THE EFFECTS OF ELEMENTARY DEPARTMENTALIZATION ON MATHEMATICS PROFICIENCY

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Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
under the Executive Committee
of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2014

ABSTRACT

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Mathematics education in the elementary schools has experienced many changes in recent decades. With the curriculum becoming more complex as a result of each modification, immense pressure has been put on schools to increase student proficiency. The Common Core State Standards is the latest example of this. These revisions to the mathematics curriculum require a comprehensive understanding of mathematics that the typical elementary teacher lacks. Some elementary schools have begun changing the organization of their classrooms from self-contained to departmentalized as a possible solution to this problem.

The purpose of this quantitative study was to examine the effects of elementary departmentalization on student mathematics proficiency. This was done by exploring and comparing the background and educational characteristics, teaching practices, assessment methods, beliefs, and influence of departmentalized elementary mathematics teachers. The study also investigated the circumstances under which there are significant differences in mathematics proficiency between departmentalized and non-departmentalized elementary students, and examined if these differences continued into students' eighth-grade years and/or led to higher level eighth-grade mathematics course attainment. Additionally, the study aimed to determine if there was a relationship between elementary departmentalization and mathematics proficiency and also to identify additional factors that could lead to mathematics proficiency.

Data came from the U.S. Department of Education's Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) data set. The ECLS-K is a national data set that followed the same children from kindergarten to eighth grade focusing on their school experiences from 1998 to 2007. Numerous statistical analyses were conducted on this rich data set, utilizing the statistical software Stata 13 and R.

The results of this study indicate that there is a significant difference in the mathematics proficiency of departmentalized and non-departmentalized students when teachers have below-average mathematics backgrounds. The students of the mathematically below-average departmentalized teachers displayed the highest mathematics proficiency as well as the biggest gain in mathematics proficiency, and these higher proficiencies and gains continued into later grade levels. However, when exploring differences in mathematics proficiency among all students, there were no conclusive differences between departmentalized and non-departmentalized students.

Regression models yielded inconclusive results as well, even after controlling for factors pertaining to classroom size, student demographics and socioeconomic status, student confidence, parental background, teacher knowledge and instructional practices, and prior student mathematical proficiency. Other findings include self-contained and departmentalized third-grade teachers being very similar in their educational backgrounds and teaching practices, whereas departmentalized and non-departmentalized fifth-grade teachers were found to be fairly different in their educational backgrounds and instructional practices. However, in both grade levels, self-contained teachers appeared to be more reliant on printed materials than departmentalized teachers.

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ACKNOWLEDGEMENTS

I am grateful to everyone who helped me on this seemingly very long journey.

I'd especially like to thank the following people:

- my parents for their constant words of encouragement along the way
- my siblings, John and Natalie, and close friends, JeNine, Lynnea, Norman, Serena, Shafeeqa, and Brandi for giving me the necessary space and not getting upset with me over the unreturned phone calls
- my advisor, Dr. Walker, for her patience, encouragement, and advisement
- Matt, for mitigating the stress of my rental property
- my statistics helper, Evan
- Dr. Vogeli, for being difficult, yet helpful in his own way
- my dissertation committee for taking the time to participate in my dissertation defense
- the Berea City School district
- Loveland Charter School
- my officemates at work, Jae Ki and Susan, for always looking out for me
- Sarah from the IRB office

DEDICATION

I dedicate this accomplishment to my grandmother, who always wanted to attend college, but never did. However, although she was never able to go to college, she made sure her granddaughters did.

CHAPTER 1

INTRODUCTION

Background

"I hate math!" is something often heard from students; however, it is something commonly heard from elementary teachers as well (Cornell, 1999; Allain, 2010; Nordquist & Miller, 2010). Not only do a significant number of elementary teachers dislike mathematics, but a large number also lack sufficient mathematical knowledge (Gellert, 2000). This lack of mathematical knowledge by many elementary teachers not only is due to their dislike of mathematics, but also can be attributed to a lack of mathematics preparation in teacher certification programs. The average elementary school teacher takes only 1.3 mathematics courses during their education (Mullich, 2009). Elementary teachers also have been found to fear mathematics and, in some cases, even suffer from mathematics anxiety (Hungerford, 1994; Leitzel, 1991). The mathematical deficiencies of these elementary teachers may be passed down to elementary students (Beilock et al., 2010) depriving students of the opportunity to build a strong foundation in mathematics.

To overcome this scenario, some school districts have changed the organization of their elementary classrooms from self-contained to departmentalized, with the implication that teachers who are better prepared mathematically would be responsible for mathematics instruction (Hood, 2009). The typical elementary self-contained classroom is structured so that students have the same teacher for all academic subject areas. In a departmentalized system, students have a different teacher for each subject area during different blocks of time (as is in most secondary schools). Fifteen years ago, approximately five percent of elementary schools departmentalized their instruction. Currently, as many as twenty percent of elementary schools are departmentalized (Hood, 2009).

Need for the Study

While there are reported advantages to departmentalization, it is not known if departmentalization leads to a better performance in mathematics. There has been a fair amount of research done regarding the effects of departmentalization on mathematics achievement, but most of it is inconclusive.

For example, *The Final Report of the National Mathematics Advisory Panel* (2008) states the following:

> Very few studies were identified that probed the effectiveness of elementary mathematics specialists of any of the three types. Out of 114 potentially relevant pieces of literature, only 1 explored the effects of mathematics specialists on student achievement in elementary schools. These authors found no difference in the mathematics gain scores of students in an elementary school with a departmentalized structure compared to students in a school with a self-contained structure. The Panel recommends that research be conducted on the use of full-time mathematics teachers in elementary schools. These would be teachers with strong knowledge of mathematics who would teach mathematics full-time to several classrooms of students, rather than teaching many subjects to one class, as is typical in most elementary classrooms. This recommendation for research is based on the Panel's findings about the importance of teachers' mathematical knowledge. The use of teachers who have specialized in elementary mathematics teaching could be a practical alternative to increasing all elementary teachers' content knowledge (a problem of huge scale) by focusing the need for expertise on fewer teachers.

In spite of the lack of research on departmentalization, a number of school districts have decided to change the structure of their elementary classrooms from self-contained instruction to departmentalized instruction (Hood, 2009). This is true, especially in the upper elementary grades. However, before even more elementary schools convert to departmentalized instruction, it needs to be determined if departmentalization actually results in higher mathematical proficiency than self-contained instruction.

Even after a century of debate regarding departmentalization in elementary schools, there is still no clear answer. Yet, the problem remains. Elementary teachers continue to be lacking in their mathematics skills, while the elementary mathematics curriculum becomes increasingly more difficult. For example, in Massachusetts, nearly three-quarters of the aspiring teachers who took the state elementary school teacher's licensing exam failed the new mathematics section (Vaznis, 2009). And in Memphis, where none of the more than 350 district elementary teachers majored in mathematics, the fifth-grade teachers are now required to prepare their students for algebraic concepts that will appear on the state test (Hood, 2009). This trend will only continue as the Common Core State Standards, which require a deeper understanding of mathematics and the ability to apply mathematics to the real world, are implemented.

Purpose of the Study

The purpose of this study is to explore the relationship between departmentalization in elementary schools and students' mathematics proficiency. This study aims to answer the following questions using quantitative research methods:

1) What are the characteristics of departmentalized elementary mathematics teachers?
2) Is there a significant difference in the background and educational characteristics, teaching practices, assessment methods, beliefs, and influence of departmentalized elementary mathematics teachers as compared to self-contained elementary teachers, and if so, what are these differences?
3) Is there a significant difference in the mathematical proficiency of elementary students who receive departmentalized classroom instruction as compared to elementary students who receive self-contained classroom instruction, and if there is, what factors contribute to this difference?

4) If there is a significant difference, does this difference continue into the eighth grade, and if it does, is the higher performing group more likely to end up in a higher-level eighth-grade mathematics course?

Procedures of the Study

The study comprises many quantitative analyses to determine if there is a relationship between elementary school departmentalization and mathematics proficiency. Using the statistical software Stata 13 and R, many analyses were conducted using the U.S. Department of Education's Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) data set, a national data set that followed the same children from kindergarten to eighth-grade focusing on their school experiences. Data were collected in the fall and spring of kindergarten (1998-99), the fall and spring of first grade (1999-2000), the spring of third grade (2002), the spring of fifth grade (2004), and the spring of eighth grade (2007). The base-year sample included more than 21,000 children and families who attended more than 1,200 public and private schools across the country. The ECLS-K data set comprises more than 18,000 variables.

A variety of statistical tests were used to analyze the ECLS-K data set and to answer the four aforementioned research questions. Summary statistics, percentage tabulations, t-tests, ANOVA with the post-hoc Bonferroni test, the Kruskal-Wallis test, the Wilcoxon-Mann-Whitney test, Fisher's Exact test, and the Chi-Square test were all used to examine the characteristics of departmentalized elementary mathematics teachers and to determine if there was a significant difference between the background characteristics of departmentalized elementary mathematics teachers and non-departmentalized elementary teachers. Additionally, t-tests and ANOVA with the post-hoc Bonferroni test determined if there was a significant difference in the mathematics proficiency of elementary departmentalized students as compared to their self-contained counterparts, and whether or not any difference continued into the eighth grade. Lastly, multiple regression was utilized to determine if classroom organization and any other factors correlate with mathematics proficiency.

Definitions of Terms Used

The following terms are used throughout the dissertation, and their definitions are provided below:

Pure Self-Contained Instruction – One teacher teaches all of the subjects to one group of students. The subjects include the academic subjects and the specialized subjects of music, art, physical education, etc. The teacher and his/her class remain in the same classroom for the school day. Thus, under this form of instruction, a student has just one teacher for the day, and his/her mathematics teacher is also his/her teacher for every other subject.

Self-Contained Instruction – One teacher teaches all of the academic subjects to one group of students. The students have specialized teachers for the specialized subjects of music, art, physical education, etc. The specialized teachers either come to the classroom to teach the students, or the students go to a designated room to be taught the specialized subject by their specialized teacher. Thus, under this type of instruction, a student's mathematics teacher is also their science, social studies, and language arts teacher.

Semi-Departmentalized Instruction – Each teacher teaches at least two academic subjects, but not all of the academic subjects. Either the teacher moves from room to room to teach different groups of students their particular subjects, or the teacher remains in the same classroom and the students change rooms. Thus, under this mode of instruction, a student's mathematics teacher will also be his/her teacher for at least one more academic subject leaving a student with two or three teachers for their academic subjects.

Departmentalized Instruction – Each teacher teaches only one academic subject in his/her area of expertise. Either the teacher moves from room to room to teach different groups of students his/her particular subject, or the teacher remains in the same classroom and the students shift from room to room throughout the school day. Thus, under this method of instruction, a student's mathematics teacher is just that, a mathematics teacher teaching only mathematics and no other subjects.

Team Teaching – Normally two (sometimes more) teachers collaborate to teach one or more of the academic subjects. Amongst themselves, the teachers decide the best way to teach the academic subjects. The teachers can teach all of the academic subjects together, split the subjects between themselves (where one may teach science and mathematics and the other may teach social studies and language arts), or any combination of the two.

Elementary School – The elementary school has changed significantly in the past 100 years. At the turn of the 20^{th} century, the majority of elementary schools comprised grades 1 – 8. From 1910 forward, elementary schools began transitioning to grades K – 6. In this study, the term elementary school will indicate that the highest grade in the school is sixth grade, unless it is explicitly stated that grades seven and eight are included.

Item Response Theory (IRT) – Item Response Theory attempts to model student ability using question level performance instead of aggregate test level performance. Instead of assuming all questions contribute equally to an understanding of a student's abilities, IRT provides a more precise view of the information each question provides about a student by taking into consideration the question type and difficulty level (Knewton, 2012).

CHAPTER II

BACKGROUND FOR THE STUDY

History of Departmentalization

Although departmentalization in elementary schools has become a hot topic as of late, departmentalization itself is not a recent innovation. Its origin began at the end of the eighteenth century, when a type of school organization known as the "departmental school" gained prominence, especially in the New England states (Bunker, 1916). The main feature of this departmental organization was the division of the school into two separate departments, a reading department and a writing department (Bunker, 1916). Students attended each department alternately; changing from one to the other at the end of each half-day's session (Bunker, 1916). Each of these departments had its own teacher, room, set of lessons, and corps of assistants (Bunker, 1916).

Even though the "departmental school" had become more common, the primary educational structure in early American education was still the one-room school (Franklin, 1967). This changed in 1848, when J.D. Philbrick, principal of Boston's Quincy Grammar School, devised the *graded school plan* (Franklin, 1967; Otto & Sanders, 1964). In this system of organization, graded courses of study were developed, students were grouped into grade levels, and one teacher per grade taught all subjects to the students within that grade (Franklin, 1967; Otto & Sanders, 1964). It was the implementation of the *graded school plan* that marked the beginning of a fifty-year trend toward self-contained instruction (Franklin, 1967; Otto & Sanders, 1964).

It was not until the beginning of the twentieth century that departmentalization reemerged. From 1900 to 1930, departmentalization was implemented increasingly (Otto

& Sanders, 1964) beginning in 1900 with its introduction into the seventh and eighth grades of New York City schools by Superintendent William H. Maxwell. Other major cities experimented with departmentalization as well. In Chicago, Superintendent Edwin Cooley published several sample programs of departmental organization at the elementary school level with accompanying reports in 1905 (Pierce, 1935). In St. Louis, Assistant Superintendent Carl G. Rathmann reported that five elementary schools in his district had departmentalized their sixth, seventh, and eighth grades. He also reported that none of the principals of these recently departmentalized schools wished to discontinue the practice (Pierce, 1935).

During this same time period, Gary, Indiana Superintendent William A. Wirt initiated a variation of departmentalization, creating what is known as a *platoon school*, where students were divided into two groups called platoons (Mohl, 1975). While one platoon attended academic classes, the other group participated in various specialized activities such as art, music, dance, science, and drama (Mohl, 1975). Alice Barrows of the U.S. Office of Education advanced the platoon concept, which prospered as a result of its focus on efficiency, humanities, and democracy in education (Mohl, 1975).

The 1930's marked intense debate between advocates of self-contained versus departmentalized approaches, while the 1940's generally saw a decline in departmentalization—although city schools frequently maintained specialists for subjects such as art, music, and physical education (Goodlad, 1960, 1966; Lobdell & Van Ness, 1967). In the 1950's, national security concerns led to more intensive curricular content in mathematics and science, and interest increased once again in departmentalization at the elementary level (Goodlad, 1960, 1966; Heathers, 1967, 1972; Lobdell & Van Ness, 1967).

With the implementation of No Child Left Behind in 2001, which includes an emphasis on standardized testing, there has been an upsurge in the implementation of departmentalization at the elementary level (Hood, 2009).

Since the beginning days of the "departmental school", departmentalization in the elementary grades has passed through a variety of stages, sometimes having disappeared almost entirely from school practices, at times being highly praised, and in other instances being condemned vigorously (Otto, 1948). Generally, however, despite the latest increase in the implementation of departmentalization, the self-contained format has remained the predominant structure for organizing elementary schools (Anderson, 1966; Goodlad, 1966; Otto & Sanders, 1964; Hood, 2009).

Early Studies

Superintendent Donald DuShane conducted one of the first studies of departmentalization in 1912, where he departmentalized the 4th, 5th, and 6th grades of the Madison, Indiana public schools (DuShane, 1916). From his observations, teacher surveys, and children interviews, he concluded that departmentalization yielded positive results in his district, e.g. children were more likely to find a teacher that understands them, there were less student failures, teachers were able to become specialists, and students under the new departmentalized plan were doing better than students under the old self-contained classroom structure, etc. (DuShane, 1916). When teachers were asked if they felt they could be more effective under the self-contained classroom structure as compared to the new departmentalized classroom organization, all of the teachers expressed they could not (DuShane, 1916). Additionally, it is important to note that DuShane indicated that the interests and aptitudes of the teachers were considered in assigning the main subject areas, and also, the change to departmentalization was discussed freely and thoroughly with each teacher (DuShane, 1916).

Another early study of departmentalization occurred in 1913, when the United States Bureau of Education sent a questionnaire regarding departmental teaching to all cities having a population of 5,000 or more. Of the 813 responses, 461 (57%) had some form of departmentalization, although very few cities reported having it below the seventh grade.

In 1929, Henry J. Otto conducted a study that examined departmentalization at the elementary level. The cities Otto focused on had populations from 2,500 to 25,000 people, and were in 31 states, excluding southern states (Otto, 1931). With a sample of 203 of these cities, he found that 37% of six-year schools (grades 1 – 6) used some form of departmental teaching in any or all of their elementary grades with most of the departmentalization occurring in the 5^{th} and 6^{th} grades. (Otto, 1931).

A study that examined the difference in achievement between elementary students in a departmentalized setting and a self-contained setting was conducted by J.R. Gerberich and C. E. Prall in 1931. They found that the relative variability of the effectiveness of the two types of organization is more noticeable in the lower grades than in the upper grades (Gerberich & Prall, 1931). They also found that students in a departmentalized setting did better in arithmetic in the fourth, fifth, and sixth grades and in English in the fourth and fifth-grades (Gerberich & Prall, 1931). When comparing the gains of the various subjects, it was shown that there was substantial superiority in the departmentalization of arithmetic (Gerberich & Prall, 1931).

In 1941-1942, Thomas Prince sent questionnaires to 200 superintendents of approximately 200 American schools and 77% responded. From his data, Prince concluded that at this time, departmentalization was being discontinued and self-contained instruction was on the rise (Prince, 1943). He concluded that, "The elementary school of today in cities of all sizes and in all sections of the country are giving more attention to the needs of the children and are placing less emphasis on subject or subject matter specialization." In 1946, Prince conducted a follow-up study and found the following: departmentalization continues to decrease but more rapidly in some areas, there is possibly a comeback in art and music specialists, and the majority of superintendents preferred pure self-contained or self-contained instruction.

In 1943, Otto conducted his own follow-up study where he sent an explanatory letter where he received data on departmentalization from 532 elementary schools from across the country. Departmentalization was reported in 66 (12.4%) of the schools. The prominent practice was to limit the number of departmentalized subjects to three or less in the primary grades, four or less in the fourth grade, and five or less in the fifth through eighth grades. Additionally, of the 38 different subjects and activities listed, music, art, physical education, arithmetic, science, social studies, and handwriting were named as the most departmentalized subject areas. The inclusion of nonacademic subjects was not uncommon in the earlier studies, so to account for this difference in meaning Otto (1945) provided a definition of departmentalization on his questionnaire in his follow-up study. He defined departmentalization as the following:

> Departmentalization is a specialization in teaching. Departmental teaching as it is commonly known is used in schools in a great variety of ways. In some schools the teachers of two contiguous grades merely exchange certain subjects; teacher A who

> has a special liking for music may teach music in both grades. While she is teaching music in the next room, the teacher B who has geography or reading or art as a favorite subject comes in to teach one of these in A's room. In some cases pupils change rooms whereas in others the teachers move about from room to room.

Another important study from the 1940's was conducted by Margaret Rouse, which focused primarily on four areas: the scope of the school curriculum, the general pattern of curriculum organization, the manner in which the school life was administered, and the procedure used in classroom teaching (Rouse, 1946). One of her findings showed that with arithmetic and writing, there was no preferred classroom structure, whereas in most of the other subjects there had been a preference for a non-departmentalized classroom structure (Rouse, 1946).

Later studies by Mary Dunn, Stuart Dean, and Roland E. Barnes continued to evaluate prevalence of departmentalization in elementary schools. Dunn's study found that from 1920 to 1949, self-contained instruction, which had been dominant throughout the 30-year period, had increased in practice from 1940 to 1949 (Dunn, 1952), similar to what Prince had found. This increase was largely due to the growing dissemination of the philosophy of total child development and continuous growth (Dunn, 1952). Dean found, by the end of the 1950's, only less than 10% of elementary schools used partial departmentalization and that complete departmentalization was almost negligible (Dean, 1960). Barnes's (1959) study led him to conclude that there was little change in the persistence of departmentalization, with the exception of elementary schools in smaller cities, where departmentalization was actually increasing. His study also showed the ranking order for the top ten departmentalized subjects: music, physical education, art, arithmetic, science, reading, social studies, library, English, and language arts.

In 1959, George Ackerlund sent surveys to teachers asking the following question: “Do you believe the self-contained classroom, in which one teacher is required to teach all subjects, is the best type of organization for elementary education?” Of those who responded, 109 said yes, and 122 said no; however, grade level, marital status, number of years in college, or level of education did not appear to be a factor in the type of response given. Ackerlund also found that even though some teachers are well prepared to teach certain subjects, it is clear they often dislike doing so. Additionally, his research led him to conclude that a higher degree of content knowledge is required, especially in the upper elementary grades. He found no evidence that adjustment to several different teaching personalities simultaneously is harmful to children, but instead that it might be valuable.

This led to the next research trend, which involved studies investigating the difference in the social adjustment between students of self-contained classrooms and students of semi-departmentalized classrooms. Robert E. McCue, who studied the adjustment of fourth graders, found that a semi-departmentalized classroom was more effective in developing growth in social adjustment and school relations. He also found that a departmentalized classroom led to a significantly greater growth in total adjustment (McCue, 1957). In Tulsa, Oklahoma, Fred C. Broadhead examined the adjustment of fifth-graders in the areas of school, home, self, people, and general, and he found that in all areas the semi-departmentalized group showed a higher level of adjustment (Broadhead, 1960). Soon after, another researcher, Dr. Livingston conducted his own study using methods similar to Broadhead’s and concluded that departmentalization does not appear to be harmful nor helpful to a student’s adjustment (Livingston, 1961).

Later Studies

It was during the 1950's that the majority of studies exploring departmentalization focused on examining its effect on academic achievement, including mathematics achievement, in elementary schools. However, the results are mixed, indicating the need for additional research.

In 1950, James E. Mauldin conducted a study at Decatur Elementary School in Texas to determine the effect of departmentalization on the academic achievement and social adjustment of fifth-grade students. He compared two fifth-grade classes. One class was self-contained and the other was departmentalized. He concluded that the self-contained group showed more improvement in the accuracy of language usage and self-expression than the departmentalized group. However, in mathematics, the results were inconclusive, as no significant difference in achievement was found between the two groups, because even though the self-contained group was at a higher ability, the departmentalized group had made more gains mathematically.

Charles Hosley (1954) found that sixth graders' achievement was higher in self-contained K – 6 elementary schools than in semi-departmentalized junior high schools, yet there was no significant difference in grade-placement scores, and the departmentalized group was superior in reading and had more varied activities and hobbies.

Monroe Spivak (1956) found that students of self-contained 7th and 8th grade elementary classrooms gained more in reading skills and gained significantly more in arithmetic skills, made more friends, and reported fewer school problems by the end of the first term, than their departmentalized peers. However, Spivak (1956) conducted his study in an underprivileged area, and he recommended that the study be repeated, but in schools of varying socioeconomic statuses. This led to Ruel Morrison's work in Atlanta (1968) where he studied the relationship between socioeconomic status and achievement level in the sixth and seventh grades in both departmentalized classrooms and self-contained classrooms. In the upper-class schools, his results were inconclusive (Morrison, 1968). In the middle-class schools, he found that the self-contained classroom was preferred to departmentalization in teaching arithmetic computation and arithmetic reasoning. In the lower-middle class schools, there was a non-significant difference that favored the departmentalized setting (Morrison, 1968).

In 1960, in North Reading, Massachusetts, Superintendent Gregory C. Coffin, (1963) did a one-year experimental trial using four elementary schools to compare departmentalized instruction and self-contained instruction. Two schools utilized a self-contained classroom structure, and two schools departmentalized their instruction. In the departmentalized schools, the departmentalized subjects included language arts, science, reading, and arithmetic (Coffin, 1963). Students of both schools were given a series of tests, under similar conditions at the same time. Based on these tests, matched pairs of students were tested again, and then retested once more at the end of the school year. The results showed that sixth graders in the departmental setting advanced two years and two months in the area of word knowledge as compared to one year and one month in the self-contained setting (Coffin, 1963). The departmentalized sixth-graders also advanced six months ahead of their self-contained peers in spelling and nine months ahead in reading. In arithmetic no significant difference between the classroom structures was found, and the fourth-graders were not significantly affected by the departmentalized classroom structure. (Coffin, 1963). At the end of the study, Coffin (1963) reported that even if there had been no difference in academic achievement, the district most likely would have continued the experiment, because every teacher was enthusiastic about the departmentalized classroom structure and was doing a better job.

Glen Robinson (1961) found that 70% of elementary school principals preferred a self-contained classroom structure. Of the principals that preferred departmentalization, more than 90% felt that departmentalization should not occur before the fourth grade. Robinson also learned, from his poll of principals, that more than 60% of principals recommended the subjects of science and mathematics be departmentalized. E. Glenadine Gibb and Dorothy C. Matala (1962) found evidence that departmentalized instruction in the fifth and sixth grades had a positive impact on student achievement in science, but no impact on mathematics achievement.

In 1970, P.E. Ward found that students in grades 4 – 6 learned reading and science significantly better in self-contained classes than in departmentalized classes; however, there were no differences found in mathematics and social studies. D.A. Case (1971) discovered an achievement benefit of departmentalization, comparing 5th graders in a new middle school to matched control students remaining in self-contained elementary classrooms. In 1976, Linda L. Lamme suggested that departmentalization negatively affected achievement in reading at the elementary school level at the conclusion of her three-year study. James M. McPartland (1987) found that self-contained instruction in the sixth grade heightened teacher-student relations at the cost of high quality, specialized instruction in the content areas.

Henry J. Becker (1987) found the achievement effects of departmentalization in 6th grades to vary by socioeconomic status. Students from the wealthiest backgrounds gained slightly, and middle-income students lost slightly, and lower class students lost substantially from departmentalized arrangements (Becker, 1987).

Carole J. McGrath and James O. Rust (2002) studied the effectiveness of departmentalized mathematics at the elementary level. The study compared gain scores in achievement test data from students in self-contained classrooms and departmentalized classrooms in grades 5 and 6. For the mathematics subtest of the achievement data, there were no significant differences in student achievement gain scores between departmentalized and self-contained classes.

Delise Andrews (2006) departmentalized the fifth grade at her school in an action research study, where she became a semi-departmentalized mathematics and social studies teacher. The results were generally inconclusive; however, there were some positive results, e.g. the prior year 24% of students had fallen into the bottom quartile on a national mathematics test, while during the year the 5th grade became departmentalized, only 9% of students fell into the bottom quartile. Additionally, the school decided to continue with the departmentalized classroom structure.

James L. DelViscio & Michael L. Muffs (2007) reported that third, fourth, and fifth-grade students in a departmentalized setting showed a definite increase in standardized test scores.

Darrell W. Moore (2008) conducted a study where he analyzed the standardized test scores of fourth and fifth-grade students in six different school systems in Tennessee, and where he also attempted to determine the effect of teacher preference for a particular type of organizational structure – self-contained or departmentalized. He concluded that there was no significant difference in academic achievement based on classroom organizational structure or teacher preference at the fourth grade level, yet at the fifth-grade level, a significant difference was found in mathematics in favor of the departmentalized setting (Moore, 2008).

In 2009, Marcia Wright Williams conducted a quantitative study to determine whether fifth-grade students who received departmentalized instruction achieved higher mean scale scores on the reading and mathematics sections of the Georgia Criterion Referenced Competency Test (CRCT) than students who were taught in a traditional setting. Using 2007 and 2008 CRCT data, she concluded that students who received instruction in a departmentalized setting scored higher on the reading and mathematics portions of the 2007 CRCT (Williams, 2009). Although, the Moore study and the Williams study are similar, neither study controlled for previous achievement (Yearwood, 2011). When comparing the Kentucky Core Content Test scores of 4th and 5th grade students based on classroom organization (self-contained vs. departmentalized), Kimberly Penn Kent found that there was no significant difference on the academic performance in the subject areas of reading and mathematics (Kent, 2010).

In 2011, Connie Yearwood conducted a study very similar to that of Williams. Yearwood also used Georgia CRCT fifth-grade scores as data, but the scores were from 2010. Additionally, she controlled for previous achievement using ANCOVA, and her findings suggested that students who received instruction in a departmentalized setting scored higher on the reading and mathematics portions of the 2010 CRCT (Yearwood, 2011).

In Toy Coles Watts' (2012) investigation of the relationship between school organizational style and student outcomes, she found no significant difference between the departmentalized and self-contained instruction. However, there was no negative impact on student outcomes as a result of a departmentalization. Also, teachers had a positive attitude toward departmentalization, indicating that teachers enjoyed teaching in that particular format.

At a moderate-sized private school in the Midwest, Mitzi Hanks (2013) found that that the majority of the students had positive perceptions toward entering a departmentalized system, and they left an experimental departmentalized program with similar attitudes. Grades for the majority of the students remained either static or improved during the course of the study. Several of the younger students in the sample group did indicate a lack of desire to enter the program and were among the few who did not perform as well academically in the departmentalized program (Hanks, 2013).

Thus, the inconsistent and inconclusive body of evidence leaves the question of which is the preferred organizational structure still unresolved. Below, Table 2.1 shows the aforementioned studies that examined the relationship between classroom organization and mathematics achievement, with the 'x' indicating the favored organization. It can be seen that the majority of the studies are inconclusive, indicating a need for further research.

Table 2.1: List of Studies That Examined the Relationship Between Classroom Organization and Mathematics Achievement and the Resulting Preferred Outcome

Study	Departmentalized	Self-Contained	Inconclusive
Gerberich and Prall (1931)	x		
Rouse (1946)			x
Mauldin (1950)			x
Hosley (1954)			x
Spivak (1956)		x	
Coffin (1960)			x
Gibb and Matala (1962)			x
Morrison (1968) [upper-class students]			x
Morrison (1968) [middle-class students]		x	
Morrison (1968) [lower-class students]	x		
Ward (1970)			x
Case (1971)	x		
Becker (1987)			x
McPartland (1987)			x
McGrath and Rust (2002)			x
Andrews (2006)			x
Moore (2008) [4thgrade]			x
Moore (2008) [5th grade]	x		
Williams (2009)	x		
Kent (2010)			x
Yearwood (2011)	x		

Advantages and Disadvantages of Departmentalization

There are a number of studies that report advantages of departmentalization. William B. Ragan stated the following as a result of his research, “Due to the demands on subject matter, particularly in science and mathematics, it is no longer possible for just one teacher to keep up. Only a teacher who has specialized in a discipline can do this. Departmentalization would allow this specialization." Daniel Tanner adds to this in 1967 and indicates that it is unrealistic to expect teachers to be highly competent instructors in all subject areas and suggests that older elementary students need instruction from specialized faculty. Richard Anderson (1967) builds upon Tanner's argument for teacher specialization and contends that teachers who are experts in their field will be better able to understand and meet the needs of the learners. Barbara Reys & Francis Fennell (2003) posited that teachers with particular knowledge and expertise in mathematics (mathematics specialists) created the best learning environment for students. Maurie Hillson and Ramona Karlson (1965) simply state, "The greater the understanding the teacher has of a subject, the greater the possibility of excellent instruction."

Since departmentalization allows teachers to be experts in their field, another advantage of departmentalization is that it prevents teachers from having to teach subjects where they do not feel comfortable and competent. Tak Cheung Chan and Delbert Jarman (2004) found that teachers in self-contained classrooms are forced to teach subjects they do not enjoy nor feel comfortable teaching. "Teachers need not be Jacks of all trades but can be masters of their fields," (Chan & Jarman, 2004, p. 70). Supporters of departmentalization believe that teachers teaching where they are skilled results in better teaching due to an in-depth body of knowledge held by the specialized teacher, as departmentalization makes it easier for the teacher to keep up with new developments in methods, materials, and equipment in one or two fields (Ragan, 1966). Thus, students become the beneficiaries of a wealth of knowledge that could not be matched in a self-contained classroom (Chan & Jarman, 2004; Reys & Fennell, 2003).

Departmentalization also eliminates the issue of a subject being passed over due to a teacher's inadequate feelings about a particular subject, since under departmentalization, a teacher is teaching a subject he or she enjoys and feels confident teaching (Johnson, 1965). F. H. Johnson (1965) also points out that children receive better instruction, because the teacher has time to be well prepared in his or her subject, and that teacher morale is higher with his or her confidence of knowledge. B. B. Hirsch (1963) makes similar findings – short well-planned and well-motivated classes lessen student boredom, and the teacher's interest and enthusiasm is contagious. Johnson's finding about departmentalized teachers having more time was echoed by several other investigators who found that under departmentalization, teachers had more time to plan effective instruction and to focus their professional development efforts to concentrate on improving delivery of their specific content area (Andrews, 2006; Becker, 1987; Page, 2009).

Another advantage to departmentalization, suggested by Anderson (1967) is that due to the variety of techniques and environments offered by departmentalization, students benefit from exposure to multiple instructors throughout the day. Chan and Jarman (2004) have expressed comparable findings. Departmentalization allows students the opportunity to explore several personalities throughout the instructional day, and to be exposed to a wide variety of teaching methods and learning experiences (Hirsch, 1963). With increased opportunities to be exposed to different personalities, the student will have multiple opportunities to broaden their social experiences and to find a teacher to bond with (Hirsch, 1963). Also, a departmentalized setting will help students develop their survival skills as they transition from the egocentrism of childhood to a group-centered learning environment (Perlstein, 2003).

Additional benefits to departmentalization include the following:

- It may attract more men to teaching in the elementary school if they are not required to teach all subjects (Ragan, 1966; Hillson & Karlson, 1965).
- It makes it easier to provide special equipment for one or two rooms in a building than it is to provide special equipment for all classrooms. (Ragan)
- Departmentalized settings better prepare students for transition to middle school (Chan & Jarman, 2004; Delviscio & Muffs, 2007).
- A weak and inexperienced teacher would not remain with the students all day. (Hirsch, 1963)

These findings in support of departmentalization were in opposition to similar studies conducted by researchers who argued departmentalization impeded teacher-student relationships, negatively impacting instruction and student mastery of concepts (Chang et al., 2008; Braddock et al., 1988). For example, Edith R. Snyder (1960) focuses an entire book on the value and operation of self-contained classrooms, indicating that "there is real cause for alarm that pressures outside the school may dictate curricular organization and content" (p. 2) and result in increased departmentalization. Rodney Tillman (1960), Lawrence Lobdell and William J. Van Ness (1967), John G. Thornell (1980), and Thomas O. Walters (1970) all joined Snyder in touting the benefits of self-contained instruction. As described by these authors, benefits include the following: individualization, flexibility in use of time, correlation of knowledge and skills across subjects, development of students' independence, and opportunities to guide and support students' emotional and psychological development.

Additional benefits to self-contained instruction include:

- Organization and scheduling problems are held to a minimum (Jenson et al., 1967).
- Communication with parents is facilitated (Jenson et al., 1967).

Other research has recommended a compromise between the two sides. In 2011, Betsy Baker conducted a qualitative study that explored the decision-making process where the choice to departmentalize the fifth grade had recently been made in a small, rural Pennsylvania district. She discovered that the institution exerts a significant influence on the decision-making process, and she observed the benefits and limitations to departmentalization firsthand (Baker, 2011). This led her to conclude that semi-departmentalization may effectively reduce the limitations typically associated with departmentalization by balancing a student-centered approach with content specificity (Baker, 2011).

CHAPTER III

METHODOLOGY

Statement of Research Questions

The purpose of this study was to explore the relationship between elementary school departmentalization and student mathematics proficiency and also to compare the effects of departmentalization to other types of classroom organization. This study aimed to answer the following research questions using quantitative methods:

1) What are the characteristics of departmentalized elementary mathematics teachers?
2) Is there a significant difference in the background and educational characteristics, teaching practices, assessment methods, beliefs, and influence of departmentalized elementary mathematics teachers as compared to self-contained elementary teachers, and if so, what are these differences?
3) Is there a significant difference in the mathematical proficiency of elementary students who receive departmentalized classroom instruction as compared to elementary students who receive self-contained classroom instruction, and if there is, what factors contribute to this difference?
4) If there is a significant difference, does this difference continue into the eighth grade, and if it does, is the higher performing group more likely to end up in a higher-level eighth-grade mathematics course?

Description of the Data Source

To answer all of the research questions posed, the investigator used the U.S. Department of Education's Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) national data set to determine if there is a significant difference in mathematics proficiency between elementary students who receive self-contained instruction and those who receive departmentalized instruction. The ECLS-K data set is a rich data set that follows the same children from kindergarten to eighth-grade providing descriptive and valuable information on children's experiences and aptitudes during these years by recording a wide range of family, community, individual, and school factors. The data were collected from direct child assessments, parent interviews, teacher surveys, administrator questionnaires, student records, and school facilities' checklists and resulted in more than 18,000 variables. The base-year sample included more than 21,000 children, as well as their families, attending more than 1,200 public and private schools across the country. Data were collected in the fall and spring of kindergarten (1998-99), the fall and spring of 1st grade (1999-2000), the spring of 3rd grade (2002), the spring of 5th grade (2004), and the spring of 8th grade (2007).

Mathematics Proficiency Assessments

The students who participated in the ECLS-K were given mathematics proficiency assessments in kindergarten, first, third, fifth, and eighth grades. The assessments in kindergarten, first, third, and fifth grade, consisted of a trained assessor performing an untimed computer-assisted direct evaluation of a child's mathematical knowledge in a one-on-one setting. In the eighth-grade, assessments consisted of evaluating students in small groups and of paper and pencil assessments. The kindergarten through eighth-grade mathematics proficiency levels range from one to nine and consist of the following:

(1) Number and Shape — identifying some one-digit numerals, recognizing geometric shapes, and one-to-one counting up to 10 objects
(2) Relative Size — reading all one-digit numerals, counting beyond 10, recognizing a sequence of patterns, and using nonstandard units of length to compare the size of objects
(3) Ordinality and Sequence — reading two-digit numerals, recognizing the next number in a sequence, identifying the ordinal position of an object, and solving a simple word problem
(4) Addition and Subtraction — solving simple addition and subtraction problems
(5) Multiplication and Division — solving simple multiplication and division problems and recognizing more complex number patterns
(6) Place Value — demonstrating an understanding of place value in integers to the hundreds' place
(7) Rate and Measurement — using knowledge of measurement and rate to solve word problems
(8) Fractions — solving problems using fractions
(9) Area and Volume — solving word problems involving area and volume

IRT scores

After the completion of a mathematics proficiency assessment, students' results were calculated into IRT scaled scores. The score calculation essentially estimated a child's performance on a complete set of assessment questions, conjecturing the number of items a child would have answered correctly at each point in time had he or she taken all 174 mathematics questions of the mathematics proficiency assessment in each round (Tourangeau, 2010). This allowed for the benefit of making longitudinal measurements of gain in mathematics proficiency over time, which was an important advantage of the IRT scale scores that some of the other ECLS-K scores lacked (Tourangeau, 2010).

Another benefit to IRT scoring was that it took into consideration the pattern of responses given to estimate the probability of a correct response for an assessment question. For example, if a student answered many of the easy lower-level mathematics questions incorrectly, but answered a few of the difficult questions correctly, it was likely that the student guessed and did not really know how to do the difficult questions. Additionally, IRT scoring was able to adjust for omitted items using this same response-pattern method, allowing for less distortion in the scores. These advantages made the IRT scale score the suitable score for analysis (Tourangeau, 2010).

Statistical Analyses

All statistical analyses were done using Stata 13 and R. Stata 13 is a complete, integrated statistical software package that allows for data analysis, data management, and graphics. Stata was one of the statistical softwares recommended by NCES for the ECLS-K data set. R is a free software environment for statistical computing and graphics, and was used in this study for the creation of regression models.

Teacher Analysis

To gain a better understanding of whom a departmentalized teacher is and what occurs in his or her classroom, the background and educational characteristics, teaching practices, assessment methods, beliefs, and influence of departmentalized mathematics teachers were examined. A summary statistical analysis was performed on a plethora of variables in these categories, providing sample size, and either a mean, standard variation, minimum, and maximum, or a percentage breakdown of the teachers' responses to survey questions.

In order to determine if there was a significant difference (at α = 0.05) between the background and educational characteristics, teaching practices, assessment methods, and the beliefs and influence of departmentalized mathematics teachers and non-departmentalized mathematics teachers, a variety of statistical analyses were used.

Questions pertaining to departmentalization and type of classroom organization are asked of teachers only during the third- and fifth-grade years. In kindergarten and first grade, it is assumed in the ECLS-K data set that departmentalization is nonexistent, and in the eighth grade, it is expected that departmentalization is ubiquitous. Thus, the teacher analyses were completed only for the third- and fifth-grade teachers.

Third-Grade Teachers

At the third-grade level, the different types of teachers consisted of self-contained, team, enrichment, and departmentalized teachers. However, due to the coding of the ECLS-K data, the team, enrichment, and departmentalized teachers were combined into one group. Thus, only two groups of teachers were compared at the third-grade level, with the self-contained teachers comprising the other group. For the purposes of this dissertation, the group consisting of the departmentalized, team, and enrichment teachers will be referred to as the departmentalized group.

When comparing the departmentalized mathematics third-grade teachers to the self-contained third-grade teachers, t-tests were used when the dependent variable was interval or continuous and there was not a significant difference in the variances. When the dependent variable was interval or continuous with a significant difference in the variances, or when the dependent variable was ordinal, the Wilcoxon-Mann-Whitney test was utilized to conduct the analysis. The Chi-Square test was used when the dependent variable was categorical, unless one of the teacher groups (departmentalized or self-contained) contained less than five teachers, for which Fisher's Exact test was used instead.

Fifth-Grade Teachers

At the fifth-grade level, three groups of teachers were compared to each other: self-contained, team, and departmentalized. Thus, the Analysis of Variance (ANOVA) test with the Bonferroni post-hoc test was used when the dependent variable was interval or continuous and when there was not a significant difference among the variances. If the dependent variable was interval or continuous with a significant difference in the variances, or when the dependent variable was ordinal, then the Kruskall-Wallis test was utilized. The Chi-Square test was used when the dependent variable was categorical, unless one of the teacher groups (self-contained, team, or departmentalized) contained less than five teachers, for which Fisher's Exact test was used instead. If a significant difference was found using the Kruskall-Wallace or Chi-Square test, then pairwise comparisons, (when $\alpha = 0.0167$ ($0.05 \div 3$) since there are three groups being tested post-hoc), were done using the Wilcoxon-Mann-Whitney test.

Student Mathematical Proficiency Analysis

Third-Grade Students

To examine the mathematics proficiency gained by third-grade students, the student groups analyzed were the same as the teacher groups that were compared: self-contained and departmentalized. The first mathematics proficiency analysis was conducted using the first-grade and third-grade IRT scores. The first-grade IRT scores were subtracted from the third-grade IRT scores resulting in the mathematics proficiency gained from first-grade to third-grade. After eliminating missing data, the IRT proficiency scores and gains of the self-contained third-grade students were then compared to the IRT proficiency scores and gains of the departmentalized third-grade students, using a t-test. If the baseline IRT scores began with a significant difference, then an analysis was conducted using a subsample where the first-grade baseline groups started with the same mean IRT score, so that there was not already a significant difference to begin with. This allowed for more accurate results.

Third-Grade Students of Mathematically Below-Average Teachers

The next analysis compared the IRT proficiency gains of only the third-grade students who had teachers with below-average mathematics backgrounds. An analysis was conducted using t-tests, comparing the self-contained and departmentalized teachers who had taken less than 2.8 college mathematics courses and participated in less than 7.95 hours of mathematics workshops in the past year. These means of 2.8 mathematics methods courses and 7.95 mathematics workshop hours were used, as these are the mean number of mathematics methods courses and mathematics workshop hours of all 4,180 third-grade teachers in the ECLS-K data set.

After a significant difference was found, the mathematically below-average groups were tested again at the fifth-grade level (comparing the gain in IRT scores from the first grade to the fifth grade) and eighth-grade level (comparing the IRT score increase from first grade to eighth grade), regardless of classroom-instruction type in the later grades, to determine if the significant difference continued. If a significant difference was found in eighth grade, a t-test was then used to determine if there was a significant difference in upper-level mathematics course attainment.

Fifth-Grade Students

In examining the mathematics proficiency gained by fifth-grade students, the student groups compared were the same as those of the teacher groups: self-contained, team, and departmentalized. To begin the analysis, the first-grade IRT scores were subtracted from the fifth-grade IRT scores, and the resulting difference was the mathematics proficiency gained from first grade to fifth grade. Then, groups were created based on classroom organization in the third and fifth grades. Since there were three types of classroom organizations at the fifth-grade level (and two types at the third-grade level), this led to the following six groups (see Figure 3.1) being compared overall:

- Self-Contained – Self-Contained
- Self-Contained – Team Teaching
- Self-Contained – Departmentalized
- Departmentalized – Self-Contained
- Departmentalized – Team Teaching

- Departmentalized – Departmentalized

After eliminating missing data, the mathematics proficiency gains of all fifth-grade students were compared using ANOVA. To determine if a significant difference was found in eighth grade, ANOVA was then run on these same six groups comparing the mathematics proficiency gain from first to eighth grade. If a significant difference was found in eighth grade, ANOVA was again used to determine if there was a significant difference in upper-level mathematics course attainment. If the baseline IRT scores began with a significant difference, then an analysis was conducted using a subsample where the first-grade baseline groups started with the same mean IRT score, so that there was not already a significant difference to begin with. This allowed for more precise results.

Fifth-Grade Students of Mathematically Below-Average Teachers

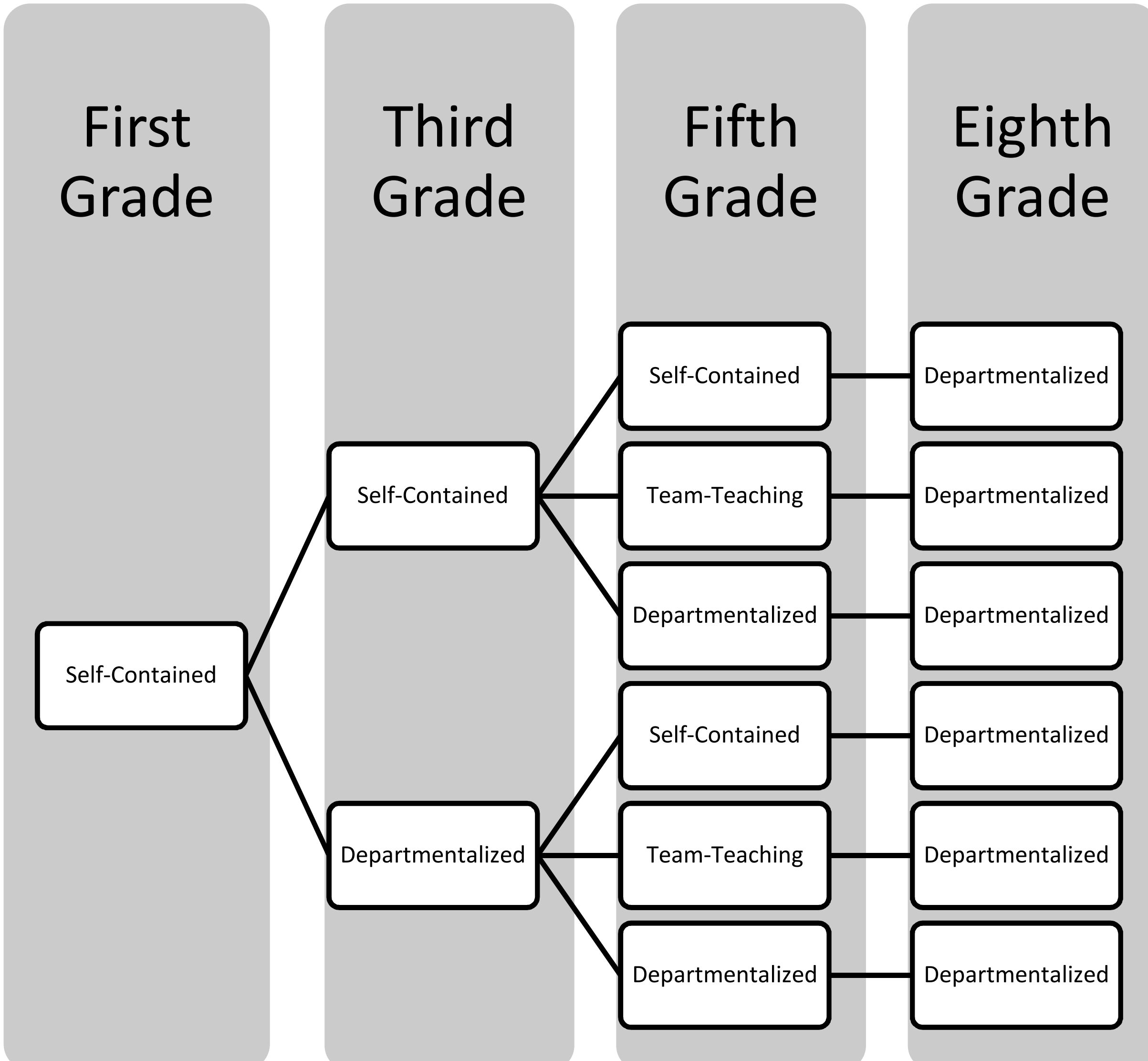
The next analysis compared the mathematics proficiency gains of only the fifth-grade students who had teachers with below-average mathematics backgrounds. Fifth-grade teachers with below-average mathematics backgrounds were those who had:

- not earned an undergraduate mathematics degree
- not earned an undergraduate mathematics education degree
- not earned a graduate mathematics degree
- not earned a graduate mathematics education degree
- taken less than 2.6 college mathematics methods courses
- attended less than 9.6 hours of mathematics workshops in the past year

The averages of 2.6 mathematics methods courses and 9.6 mathematics workshop hours were used since these are the mean number of mathematics methods courses and mathematics workshop hours of all 2,204 fifth-grade teachers in the ECLS-K data set.

With ANOVA, the fifth-grade mathematics proficiency gains were compared among the six aforementioned groups, including only the students of teachers with below-average mathematics backgrounds. ANOVA was then used to compare the mathematics proficiency gain from first to eighth grade of these students and to determine if there was a significant difference in upper-level mathematics course attainment.

Figure 3.1: Longitudinal Group Comparisons



Regression Models

Three types of regression models were created for each grade level: third grade, fifth grade, and eighth grade. The first type of regression model consisted of only the input variable, classroom organization, and the output variable, gain in mathematics proficiency to determine if departmentalization has a direct effect on mathematics proficiency. At the fifth- and eighth-grade levels, interaction of third- and fifth-grade departmentalization was included in the regression model as well.

The second and third types of regression models were created by first designating the variables made available in the ECLS-K data set that prior research had shown to have a strong correlation with mathematics proficiency. These variables, along with variables associated with departmentalization and teacher differences, were included as possible factors that relate to mathematics proficiency:

- type of classroom organization
- size of class (Pong & Pallas, 2001)
- student confidence and motivation
- student demographics
- parental involvement (Paz, Sheldon & Epstein, Sirvani)
- parent background
- socioeconomic status
- prior student mathematical proficiency (Claessens & Engel, 2013)
- significant differences found between third- and fifth-grade teachers
- factors that relate to teacher knowledge

Using backward stepwise model selection, the second model dropped all variables where $\rho \geq .05$, with the exception of classroom organization. The third and final model dropped all variables with $\rho \geq .05$, including classroom organization if necessary, allowing for a reduction in the number of variables, thus containing only variables that are significant.

CHAPTER IV

FINDINGS

The study addresses four specific questions examining elementary departmentalization and its effects on mathematics proficiency:

1) What are the characteristics of departmentalized elementary mathematics teachers?
2) Is there a significant difference in the background and educational characteristics, teaching practices, assessment methods, beliefs, and influence of departmentalized elementary mathematics teachers as compared to self-contained elementary teachers, and if so, what are these differences?
3) Is there a significant difference in the mathematical proficiency of elementary students who receive departmentalized classroom instruction as compared to elementary students who receive self-contained classroom instruction, and if so, what other factors contribute to this difference?
4) If there is a significant difference, does this difference continue into the eighth grade, and if so, is the higher performing group more likely to end up in a higher-level eighth-grade mathematics course?

To answer the research questions posed, a background analysis of departmentalized elementary mathematics teachers, a comparison of non-departmentalized and departmentalized elementary teachers, a comparison between the mathematics proficiency of departmentalized and non-departmentalized students, and the identification of factors that have a relationship with mathematics proficiency were all part of the quantitative analysis conducted. Using the ECLS-K national data set, this analysis provided answers to each of the four research questions.

Third-Grade Teacher Background and Comparison Analysis

There were two groups of third-grade teachers, self-contained and departmentalized, with the departmentalized group comprising team, enrichment, and departmentalized teachers, due to the coding of the ECLS-K data set. Since third-grade departmentalization was not a focus of the ECLS-K, the teachers are not sorted in any way based on subject area, as they are in fifth grade. Due to this, the researcher tabulated all of the third-grade teachers and excluded those that indicated they do not teach mathematics at all. Also excluded from the analysis were the third-grade teachers for which there were missing data regarding if they were in the self-contained or departmentalized group and whether or not they taught mathematics. This left a total of 4,180 third-grade teachers to be analyzed, as shown in Table 4.1.

Table 4.1: Third-Grade Teachers Who Teach Mathematics

Classroom Organization	Third-Grade Teachers
Self-Contained	3,783 (90.5%)
Departmentalized	397 (9.5%)
Total	4,180

Summary statistics were completed on the background characteristics and the mathematics backgrounds of third-grade departmentalized mathematics teachers. Tables 4.2 and 4.3 show these results. It should be noted that missing data caused for sample sizes to vary throughout the entire analysis. Tabulations were done on two other facets of departmentalized mathematics teachers' educational backgrounds as shown in Tables 4.4 and 4.5. Furthermore, the comparison t-tests and Wilcoxon-Mann-Whitney tests revealed that there was not a significant difference between the third-grade self-contained and the departmentalized mathematics teachers in any of the background characteristics or educational background variables listed in Tables 4.2, 4.3, 4.4, and 4.5.

Table 4.2: Third-Grade Departmentalized Mathematics Teachers' Background Characteristics

Variable	Sample Size		Mean	Standard Deviation	Minimum	Maximum
Age	381		42.3	11.4	24	62
Number Of Years Teaching	391		14.6	10.3	1	35
Number Of Years Teaching 3rd Grade	391		7.0	6.3	1	27
Number Of Years Teaching At Current School	385		9.1	7.8	1	30

Table 4.3: Third-Grade Departmentalized Mathematics Teachers' Mathematics Backgrounds

Variable	Sample Size		Mean	Standard Deviation	Minimum	Maximum
Number Of Mathematics Methods Courses Taken	376		2.8	1.8	0	6
Number of Hours Spent In Mathematics Workshops In the Past Year	371		8.6	20.3	0	245

Table 4.4: Third-Grade Departmentalized Mathematics Teachers' Teaching Certification Type

Variable	Sample Size		None	Temporary/ Probational Certification	Alternative Program Certification	Regular Or Standard State Certification	Advanced Professional Certificate
Type Of Teaching Certificate	386		4 (1.0%)	30 (7.8%)	9 (2.3%)	293 (75.9%)	50 (13.0%)

Table 4.5: Third-Grade Departmentalized Mathematics Teachers' Highest Education Achieved

Variable	Sample Size		High School, Associate's, Bachelor's	At Least One Year Beyond a Bachelor's	Master's Degree	Education Specialist, Professional Diploma, Doctorate
Highest Education Level Achieved	390		100 (25.6%)	113 (29.0%)	138 (35.4%)	39 (10%)

The next set of analyses describes the assessment and evaluation practices of third-grade departmentalized mathematics teachers. The tabulated results are shown in

Tables 4.6, 4.7, 4.8, 4.9, and 4.10, with * indicating a significant difference between departmentalized and self-contained teachers was found. There were three variables that displayed a significant difference. The first significant difference found was in the frequency that textbook chapter-end tests were given to students. Almost eight percent more self-contained teachers used the mathematics textbook chapter-end tests at least once or twice a week as compared to departmentalized mathematics teachers.

The next significant difference pertained to how often teachers used worksheets in the classroom, with approximately seven percent more self-contained teachers using worksheets at least once or twice a week as compared to departmentalized teachers. The third significant difference involved the frequency of work samples given to students, where more self-contained teachers used work samples three or more times a week than did departmentalized teachers by a margin of 5%.

Table 4.6: Frequency with Which Third-Grade Departmentalized Mathematics Teachers Give Assessments

Variable	Sample Size		Never	1 or 2 Times A Year	1 or 2 Times A Month	1 or 2 Times A Week	3 or More Times A Week
State/Local Standardized Tests	393		28 (7.1%)	328 (83.5%)	25 (6.4%)	7 (1.8%)	5 (1.3%)
Commercially Made Tests Or Quizzes	379		75 (22.2%)	75 (19.8%)	156 (41.2%)	62 (16.4%)	3 (0.5%)
Teacher-Made Tests Or Quizzes	393		9 (2.3%)	16 (4.1%)	184 (46.8%)	169 (43%)	15 (3.8%)
Individual Or Group Projects	388		15 (3.9%)	80 (20.6%)	223 (57.5%)	58 (15.0%)	12 (3.1%)
Textbook Chapter-End Tests*	393		48 (12.2%)	34 (8.7%)	215 (54.7%)	91 (23.2%)	5 (1.3%)
Worksheets*	393		17 (4.3%)	20 (5.1%)	87 (22.1%)	162 (41.2%)	107 (27.2%)
Work Samples*	391		16 (4.1%)	18 (4.6%)	82 (21.0%)	181 (46.3%)	94 (24.0%)

* indicates a significant difference between self-contained and departmentalized teachers with $\alpha = 0.05$

Table 4.7: Third-Grade Departmentalized Mathematics Teachers' Expectations of Students

Variable	Sample Size		Same Standards, Exceptions For Needs	Different Standards Based On Talents	Exactly The Same Standards
Teacher's Evaluation Practices	389		271 (69.7%)	87 (22.4%)	31 (8.0%)

Table 4.8: Third-Grade Departmentalized Mathematics Teachers' Methods of Evaluation

Variable	Sample Size		Not Important	Somewhat Important	Very Important	Extremely Important	N/A
Evaluate Child Relative To Class	394		28 (7.1%)	187 (47.5%)	119 (30.2%)	56 (14.2%)	4 (1.0%)
Evaluate Child Relative To Standard	392		25 (6.4%)	137 (35.0%)	140 (35.7%)	85 (21.7%)	5 (1.3%)
Evaluate Child Improvement /Progress	394		0 (0%)	15 (3.8%)	146 (37.1%)	232 (58.9%)	1 (0.3%)
Evaluate Child's Effort	395		1 (0.3%)	10 (2.5%)	117 (29.6%)	267 (67.6%)	0 (0%)
Evaluate Child Participation	395		2 (0.5%)	51 (12.9%)	173 (43.8%)	169 (42.8%)	0 (0%)
Evaluate Child's Class Behavior	395		6 (1.5%)	44 (11.1%)	129 (32.7%)	216 (54.7%)	0 (0%)
Evaluate Completion Of Homework	394		3 (0.8%)	67 (17.0%)	152 (38.6%)	169 (42.9%)	3 (0.8%)

Table 4.9: How Helpful Third-Grade Departmentalized Mathematics Teachers' Find Standardized Test Scores

Variable	Sample Size		Not Useful	Somewhat Useful	Very Useful	Extremely Useful
Usefulness Of Standardized Test Scores	332		42 (12.7%)	170 (51.2%)	94 (28.3%)	26 (7.8%)

Table 4.10: Third-Grade Departmentalized Mathematics Teachers' Use of Standardized Test Scores

Variable	Sample Size		Yes %	No %
School Uses Standardized Scores to Assess Students	397		35 (8.8%)	362 (91.2%)
Teachers Have Access To Standardized Test Scores	351		336 (95.7%)	15 (4.3%)

The next variables analyzed were those of teacher influence and curriculum control, and a significant difference was found in how much influence teachers have on policy. Four percent more of departmentalized mathematics teachers indicated they had a great deal of influence on policy as compared to self-contained teachers.

Table 4.11: Third-Grade Departmentalized Mathematics Teachers' Influence On Policy

Variable	Sample Size		No Influence	Slight Influence	Some Influence	Moderate Influence	A Great Deal Of Influence
How Much Influence Do Teachers Have On Policy*	389		22 (5.6%)	80 (20.6%)	106 (27.3%)	100 (25.7%)	81 (20.8%)

* indicates a significant difference between self-contained and departmentalized teachers with α = 0.05

Table 4.12: Third-Grade Departmentalized Mathematics Teachers' Control Over Curriculum

Variable	Sample Size		No Control	Slight Control	Some Control	Moderate Control	A Great Deal Of Control
How Much Do Teachers Control Curriculum	391		0 (0%)	19 (4.9%)	58 (14.8%)	126 (32.2%)	188 (48.0%)

Variables about teachers' beliefs and concerns regarding their job were also analyzed. The results revealed that four percent more of departmentalized mathematics teachers strongly agree that the teachers in their school seek and learn new ideas as compared to self-contained teachers.

Table 4.13: Third-Grade Departmentalized Mathematics Teachers' Beliefs And Concerns About Their Job

Variable	Sample Size		Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
Academic Standards Too Low	393		152 (38.7%)	186 (47.3%)	36 (9.2%)	17 (4.3%)	2 (0.5%)
Teacher Enjoys Present Teaching Job	392		5 (1.3%)	7 (1.8%)	21 (5.4%)	175 (44.6%)	184 (47.0%)
Teacher Makes Difference in Children's Lives	393		1 (0.3%)	7 (1.8%)	19 (4.8%)	199 (50.6%)	167 (42.5%)
Staff Members Accept Me As Colleague	391		2 (0.5%)	5 (1.3%)	11 (2.8%)	176 (45.0%)	197 (50.4%)
Paperwork Interferes With Teaching	390		23 (5.9%)	70 (18.0%)	111 (28.5%)	115 (29.5%)	71 (18.2%)
Parents Support School Staff	391		6 (1.5%)	42 (10.7%)	63 (16.1%)	228 (58.3%)	52 (13.3%)
Children Not Capable of Learning	389		112 (28.8%)	195 (50.1%)	35 (9%)	42 (10.8%)	5 (1.3%)
Child Misbehavior Affects Teaching	391		106 (27.1%)	155 (39.6%)	62 (15.9%)	54 (13.8%)	14 (3.6%)
Agreement Exists By Faculty About School Mission	391		6 (1.5%)	16 (4.1%)	48 (12.3%)	224 (57.3%)	97 (24.8%)
School Administration Communicates Vision	392		5 (1.3%)	30 (7.7%)	50 (12.8%)	173 (44.1%)	134 (34.2%)

Table 4.14: Additional Third-Grade Departmentalized Mathematics Teachers' Beliefs And Concerns About Their Job

Variable	Sample Size		Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
School Administration Handles Outside Pressure	392		9 (2.3%)	33 (8.4%)	71 (18.1%)	167 (42.6%)	112 (28.6%)
School Administration Prioritizes Well	391		3 (0.8%)	32 (8.2%)	72 (18.4%)	182 (46.6%)	102 (26.1%)
School Administration Encourages Staff	389		6 (1.5%)	23 (5.9%)	49 (12.6%)	169 (43.4%)	142 (36.5%)
Student Physical Conflicts Are A Serious Problem	392		109 (27.8%)	183 (46.7%)	51 (13.0%)	36 (9.2%)	13 (3.3%)
Teachers In The School Seek/Learn New Ideas*	391		0 (0%)	6 (1.5%)	33 (8.4%)	188 (48.1%)	164 (41.9%)
Children Bullying Other Children Is A Serious Problem	392		96 (24.5%)	174 (44.4%)	61 (15.6%)	48 (12.2%)	13 (3.3%)
Would Choose Teaching Again As A Career	393		10 (2.5%)	22 (5.6%)	52 (13.2%)	147 (37.4%)	162 (41.2%)
Teacher Is Satisfied With Class Size	391		24 (6.1%)	73 (18.7%)	21 (5.4%)	143 (36.6%)	130 (33.3%)
Teacher Is Concerned About Job Security Due To State/Local Tests	391		122 (31.2%)	141 (36.1%)	84 (21.5%)	32 (8.2%)	12 (3.1%)
Staff Members Have School Spirit	391		4 (1.0%)	14 (3.6%)	39 (10.0%)	214 (54.7%)	120 (30.7%)

* indicates a significant difference between self-contained and departmentalized teachers with $\alpha = 0.05$

Teaching practices were analyzed next, and significant differences were found in the frequency teachers used real-life mathematics problems, mathematics textbooks, achievement groups for mathematics, and television programs. A higher percentage of departmentalized mathematics teachers were found to discuss real-life mathematics problems almost every day as compared to self-contained teachers. Approximately four percent more self-contained teachers used mathematics textbooks almost every day as compared to departmentalized teachers, and while almost 28% of departmentalized teachers utilized achievement groups for mathematics, only 12% of self-contained teachers used mathematics achievement groups. Lastly, 6% more of self-contained teachers either never used the television or didn't have access to a television for teaching purposes when compared to departmentalized teachers.

Table 4.15: Third-Grade Departmentalized Mathematics Teachers' Teaching Methods Frequency

Variable	Sample Size		Almost Every Day	Once Or Twice A Week	Once Or Twice A Month	Never Or Hardly Ever
Frequency Used Math Textbooks*	388		224 (57.7%)	85 (21.9%)	17 (4.4%)	62 (16.0%)
Frequency Used Math Worksheets	393		225 (57.3%)	140 (35.6%)	23 (5.9%)	5 (1.3%)
Frequency Used Math Groups	392		118 (30.1%)	207 (52.8%)	50 (12.8%)	17 (4.3%)
Frequency Students Take Mathematics Tests	393		6 (1.5%)	166 (42.2%)	207 (52.7%)	14 (3.6%)
Frequency Child Discusses Math Problems	393		149 (37.9%)	158 (40.2%)	65 (16.5%)	21 (5.3%)
Frequency Students Discuss Real Life Mathematics Problems*	391		151 (38.6%)	162 (41.4%)	65 (16.6%)	13 (3.3%)
Frequency Used A Computer For Math	392		36 (9.2%)	102 (26.0%)	100 (25.5%)	154 (39.3%)

* indicates a significant difference between self-contained and departmentalized teachers with $\alpha = 0.05$

Table 4.16: Third-Grade Departmentalized Mathematics Teachers' Frequency In Covering Mathematics Topics

Variable	Sample Size		A Lot	Some	A Little	None
Frequency Teacher Covers Numbers And Operations	393		377 (95.9%)	14 (3.6%)	2 (0.5%)	0 (0%)
Frequency Teacher Covers Measurement	394		109 (27.7%)	240 (60.9%)	44 (11.2%)	1 (0.3%)
Frequency Teacher Covers Geometry	393		81 (20.6%)	251 (63.9%)	58 (14.8%)	3 (0.8%)
Frequency Teacher Covers Data Analysis	393		83 (21.1%)	207 (52.7%)	88 (22.4%)	15 (3.8%)
Frequency Teacher Covers Algebra	392		68 (17.4%)	192 (49.0%)	93 (23.7%)	39 (10.0%)
Frequency Teacher Covers Math Facts/Concepts	394		372 (94.4%)	21 (5.3%)	1 (0.3%)	0 (0%)
Frequency Teacher Covers Learning To Solve Routine Problems	394		362 (91.9%)	30 (7.6%)	2 (0.5%)	0 (0%)
Frequency Teacher Covers Developing Reasoning	394		253 (64.2%)	127 (32.2%)	14 (3.6%)	0 (0%)
Frequency Teacher Covers Communicate Mathematics Ideas	394		207 (52.5%)	149 (37.8%)	37 (9.4%)	1 (0.3%)
Frequency Teacher Covers Recognizing Shapes and Properties	394		114 (28.9%)	216 (54.8%)	61 (15.5%)	3 (0.8%)
Frequency Teacher Covers Whole Number Place Value	394		300 (76.1%)	86 (21.8%)	8 (2.0%)	0 (0%)
Frequency Teacher Covers Reading, Writing, Comparing Fractions	391		83 (21.2%)	204 (52.2%)	91 (23.3%)	13 (3.3%)
Frequency Teacher Covers Estimate Quantities	392		153 (39.0%)	193 (49.2%)	45 (11.5%)	1 (0.3%)

Table 4.17: Third-Grade Departmentalized Mathematics Teachers' Use of Standardized Test Scores

Variable	Sample Size	Never	Once A Month Or Less	2 Or 3 Times A Month	1 or 2 Times A Week	3 or 4 Times A Week	Daily
Frequency Use Of VCR	378	11 (2.9%)	145 (38.4%)	142 (37.6%)	66 (17.5%)	7 (1.9%)	7 (1.9%)
Frequency Use Of TV Programs*	312	132 (42.3%)	91 (29.2%)	30 (9.6%)	24 (7.7%)	5 (1.6%)	30 (9.6%)

* indicates a significant difference between self-contained and departmentalized teachers with α = 0.05

Table 4.18: Third-Grade Departmentalized Mathematics Teachers' Achievement Group Usage

Variable	Sample Size	Never	Less Than Once A Week	Once Or Twice A Week	Three Or Four Times A Week	Daily
Achievement Groups For Math*	390	79 (20.3%)	86 (22.1%)	71 (18.2%)	45 (11.5%)	109 (28.0%)

* indicates a significant difference between self-contained and departmentalized teachers with α = 0.05

Table 4.19: Third-Grade Departmentalized Mathematics Teachers' Homework Expectations

Variable	Sample Size	None	10 Minutes	20 Minutes	30 Minutes	More Than 30 Minutes
Amount of Time Expected For Homework By Students Daily	391	8 (2.1%)	156 (39.9%)	155 (39.6%)	63 (16.1%)	9 (2.3%)

Table 4.20: Third-Grade Departmentalized Mathematics Teachers' Curricula Integration Frequency

Variable	Sample Size	Never	Occasionally	Usually	All The Time
How Often Do You Integrate Curricula	394	10 (2.5%)	178 (45.2%)	166 (42.1%)	40 (10.2%)

Table 4.21: How Often Third-Grade Departmentalized Mathematics Teachers Hold

Variable	Sample Size	1 – 30 Minutes A Day	31 – 60 Minutes A Day	61 – 90 Minutes A Day	More Than 90 Minutes A Day
How Often Do You Have Math – Lessons, In Group, etc.	384	10 (2.6%)	242 (63.0%)	123 (32.0%)	9 (2.3%)

Mathematics Class

Table 4.22: Amount Of Time Spent On Standardized Test Preparation By Third-Grade Departmentalized Mathematics Teachers

Variable	Sample Size	Mean	Standard Deviation	Minimum	Maximum
Hours Spent Preparing Class For Standardized Tests	291	12.08	14.07	0	80

Table 4.23: Third-Grade Departmentalized Mathematics Teachers' Use Of Math Area

Variable	Sample Size	Yes %	No %
Math Area With Manipulatives	395	281 (71.1%)	114 (28.9%)

Table 4.24: How Useful Third-Grade Departmentalized Mathematics Teachers Find Mathematics Workshops

Variable	Sample Size	Not At All Useful	Slightly Useful	Moderately Useful	Very Useful
Usefulness Of Teaching Of Mathematics Or Mathematics Activities	241	5 (2.1%)	45 (18.7%)	92 (38.2%)	99 (41.1%)

Table 4.25 provides a summary of all of the third-grade teacher variables where a significant difference exists.

Table 4.25: Third-Grade Teacher Background Variables Where A Significant Difference Is Present

Significantly Different 3rd Grade Variable	**Significant Difference Explanation**
Frequency Textbook Chapter-End Tests Are Given	Almost 8% more self-contained teachers used the mathematics textbook chapter-end tests at least once or twice a week as compared to departmentalized mathematics teachers.
Frequency Worksheets Are Given	Approximately seven percent more self-contained teachers used worksheets at least once or twice a week as compared to departmentalized teachers.
Frequency Work Samples Are Given	More self-contained teachers used work samples three or more times a week than did departmentalized teachers by a margin of 5%.
How Much Influence Do Teachers Have On Policy	Four percent more of departmentalized mathematics teachers indicated they had a great deal of influence on policy as compared to self-contained teachers.
Teachers In The School Seek/Learn New Ideas	Four percent more of departmentalized mathematics teachers strongly agree that the teachers in their school seek and learn new ideas as compared to self-contained teachers.
Frequency Use Of Math Textbooks	Approximately four percent more self-contained teachers used mathematics textbooks almost every day, as compared to departmentalized teachers.
Frequency Students Discuss Real Life Mathematics Problems	A higher percentage of departmentalized mathematics teachers were found to discuss real-life mathematics problems almost every day as compared to self-contained teachers.
Frequency Use Of TV Programs	Six percent more of self-contained teachers either never used the television or didn't have access to a television for teaching purposes as compared to departmentalized teachers.
Achievement Groups For Mathematics	Almost 28% of departmentalized teachers utilized achievement groups for math whereas only 12% of self-contained teachers used mathematics achievement groups.

Fifth-Grade Teacher Background and Comparison Analysis

There were three groups of fifth-grade teachers: self-contained, team, and departmentalized. It is in fifth grade that departmentalization is truly given consideration in the ECLS-K data collection process, as separate questionnaires were given to sample children's reading/language arts, mathematics, and science teachers. A child's reading/language arts teacher was always given a questionnaire, but half of the students' math teachers received a questionnaire and the remaining half's science teachers received questionnaires. This helped to verify that the teachers included in the analysis taught mathematics. Table 4.26 shows the number of 5th grade mathematics teachers in the data set. After removing missing values for the variables of class organization and all of the science teachers, in addition to the 485 departmentalized mathematics teachers, there were 348 mathematics team teachers, and 1,371 self-contained teachers that taught mathematics. Thereafter, statistical analyses were done on numerous variables revealing a number of statistically significant differences as shown in tables 4.27 to 4.49, with * indicating a significant difference. Detailed explanations regarding the significant differences and the pairwise comparisons are provided in tables 4.50 through 4.54.

Table 4.26: Fifth-Grade Teachers Who Teach Mathematics

Classroom Organization	Fifth-Grade Teachers
Self-Contained	1,371 (62.2%)
Team-Teaching	348 (15.8%)
Departmentalized	485 (22%)
Total	2,204

Summary statistics were completed on the background characteristics and the educational backgrounds of fifth-grade departmentalized mathematics teachers. The ANOVA, Kruskall-Wallis, and Chi-Square tests revealed eight significant differences between the fifth-grade self-contained, team, and departmentalized mathematics teachers in the background characteristic and educational background variables. Tables 4.27, 4.28, 4.29, and 4.30 show these results.

The first significant difference revealed that the fifth-grade self-contained teachers have taught 5th grade on average for 6.5 years whereas departmentalized teachers have taught 5th grade for 7.1 years. Other significant differences include less than 5% of both self-contained and team teachers having an undergraduate degree in mathematics as compared to almost 10% of departmentalized teachers, and approximately 4% of self-contained teachers having an undergraduate degree in mathematics education, compared to 7.6% of departmentalized teachers.

Additionally, about 38% of departmentalized teachers are certified to teach elementary mathematics as compared to approximately 32% of self-contained teachers, and about 9% of self-contained teachers and 11% of team teachers had middle/secondary mathematics certification, yet more than 18% of departmentalized teachers had this type of certification. Also, about 87% of departmentalized teachers are certified in elementary education, whereas almost 97% of self-contained teachers are, and roughly 70% of self-contained teachers were found to possess an undergraduate degree in elementary education whereas 80% of team teachers possessed an undergraduate degree in elementary education. Lastly, in the previous year, self-contained teachers participated in 8.7 hours of mathematics workshops, whereas departmentalized teachers participated 12.3 hours.

Table 4.27: Fifth-Grade Departmentalized Mathematics Teachers' Background Characteristics

Variable	Sample Size		Mean	Standard Deviation	Minimum	Maximum
Age	473		42.5	11.5	23	64
Number Of Years Teaching	484		14.6	10.5	1	35
Number Of Years Teaching 5th Grade*	483		8.1	7.1	1	27
Number Of Years Teaching At Current School	484		8.5	7.7	1	30

* indicates a significant difference at $\alpha = 0.05$

Table 4.28: Fifth-Grade Departmentalized Mathematics Teachers' Degree and Certification Attainment

Variable	Sample Size		Yes %	No %
Undergraduate Degree In Mathematics*	465		45 (9.7%)	420 (90.3%)
Undergraduate Degree In Mathematics Education*	465		34 (7.3%)	431 (92.7%)
Graduate Degree In Mathematics	209		7 (3.4%)	202 (96.7%)
Graduate Degree In Mathematics Education	209		8 (3.8%)	201 (96.2)
Certified To Teach Elementary Mathematics*	473		181 (38.3%)	292 (61.7%)
Certification in Middle School/J.H./Secondary Math*	474		87 (18.4%)	387 (81.7%)
Certified in Elementary Education*	474		411 (86.7%)	63 (13.3%)
Undergraduate Degree in Elementary Education*	466		339 (72.8%)	127 (27.3%)

* indicates a significant difference at $\alpha = 0.05$

Table 4.29: Fifth-Grade Departmentalized Mathematics Teachers' Educational Background

Variable	Sample Size		Mean	Standard Deviation	Minimum	Maximum
Number Of Mathematics Methods Courses Taken	468		2.8	1.9	0	6
Number Of Elementary Methods Courses Taken	466		5.2	1.8	0	6
Number Of Hours In Mathematics Workshops In The Past Year*	469		12.3	17.4	0	192

* indicates a significant difference at $\alpha = 0.05$

Table 4.30: Fifth-Grade Departmentalized Mathematics Teachers' Highest Education Attained

Variable	Sample Size		High School, Associate's, Bachelor's	At Least One Year Beyond a Bachelor's	Master's Degree	Education Specialist, Professional Diploma, Doctorate
Highest Education Level Achieved	477		139 (29.1%)	126 (26.4%)	165 (34.6%)	47 (9.9%)

The next set of analyses focused on the assessment and evaluation practices of fifth-grade departmentalized mathematics teachers and revealed six significant differences as indicated by the tabulated results shown in Tables 4.31, 4.32, 4.33, 4.34, and 4.35. The six significant differences include approximately 6% of self-contained teachers giving state/local standardized tests at least once or twice a week, as compared to less than 3% of departmentalized teachers and teacher-made tests/quizzes being given 3 – 4 times a week by 11.4% of self-contained teachers, 9.3%, of team teachers, and only 3.5% of departmentalized teachers. Other significant differences found include textbook chapter-end tests being given at least once or twice a week by 43.7% of self-contained teachers, 31.6%, of team teachers, and 25.3% of departmentalized teachers and projects being given at least once or twice a week by 19.1% of self-contained teachers, 17.6%, of team teachers, and about 14% of departmentalized teachers. Also, slightly more than 34% of self-contained teachers were found to give work samples three or four times a week as compared to 27% of team teachers. Additionally, slightly more than 43% of departmentalized teachers found standardized test scores either very or extremely useful, as compared to 35.1% of self-contained teachers.

Table 4.31: Fifth-Grade Departmentalized Mathematics Teachers' Evaluation Practices I

Variable	Sample Size		Not Important	Somewhat Important	Very Important	Extremely Important	N/A
Evaluate Child Relative To Class	483		42 (8.7%)	183 (37.9%)	181 (37.5%)	74 (15.3%)	3 (.6%)
Evaluate Child Relative To Standard	481		18 (3.7%)	140 (29.1%)	172 (35.8%)	148 (30.8%)	3 (.6%)
Evaluate Child Improvement/ Progress	482		0 (0%)	14 (2.9%)	153 (31.7%)	315 (65.4%)	0 (0%)
Evaluate Child's Effort	484		0 (0%)	13 (2.7%)	118 (24.4%)	353 (72.9%)	0 (0%)
Evaluate Child Participation	484		1 (0.2%)	60 (12.4%)	208 (43.0%)	215 (44.4%)	0 (0%)
Evaluate Child's Class Behavior	483		11 (2.3%)	63 (13.0%)	162 (33.5%)	247 (51.1%)	0 (0%)
Evaluate Completion Of Homework	483		5 (1.0%)	62 (12.4%)	173 (35.8%)	239 (49.5%)	4 (.8%)

Table 4.32: Fifth-Grade Departmentalized Mathematics Teachers' Standards Expectations

Variable	Sample Size		Same Standards, Exceptions For Needs	Different Standards Based On Talents	Exactly The Same Standards
Teacher's Evaluation Practices	479		316 (66.0%)	94 (19.6%)	69 (14.4%)

Table 4.33: Fifth-Grade Departmentalized Mathematics Teachers' Frequency of Assessments

Variable	Sample Size		Never	1 or 2 Times A Year	1 or 2 Times A Month	1 or 2 Times A Week	3 or More Times A Week
State/Local Standardized Tests*	481		26 (5.4%)	391 (81.3%)	47 (9.8%)	11 (2.3%)	6 (1.3%)
Teacher-Made Tests Or Quizzes*	484		10 (2.1%)	16 (3.3%)	190 (39.3%)	251 (51.9%)	17 (3.5%)
Textbook Chapter-End Tests*	482		50 (10.4%)	30 (6.2%)	280 (58.1%)	111 (23.0%)	11 (2.3%)
Individual Or Group Projects*	476		29 (6.1%)	110 (23.1%)	271 (56.9%)	56 (11.8%)	10 (2.1%)
Worksheets	481		14 (2.9%)	7 (1.5%)	69 (14.4%)	229 (47.6%)	162 (33.7%)
Work Samples*	475		17 (3.6%)	21 (4.4%)	111 (23.4%)	171 (36.0%)	155 (32.6%)

* indicates a significant difference $\alpha = 0.05$

Table 4.34: Fifth-Grade Departmentalized Mathematics Teachers' Assessment Practices

Variable	Sample Size		Yes %	No %
Does School Assess Students With Standardized Tests	485		447 (92.2%)	38 (7.8%)
Access To Standardized Test Scores	436		431 (98.9%)	5 (1.2%)

Table 4.35: Fifth-Grade Departmentalized Mathematics Teachers' Usefulness of Standardized Test Scores

Variable	Sample Size		Not Useful	Somewhat Useful	Very Useful	Extremely Useful
Usefulness Of Standardized Test Scores*	430		23 (5.4%)	222 (51.6%)	144 (33.5%)	41 (9.5%)

* indicates a significant difference at $\alpha = 0.05$

The next variables analyzed were those of teacher influence and control with the results displayed in tables 4.36 and 4.37.

Table 4.36: Fifth-Grade Departmentalized Mathematics Teachers' Influence

Variable	Sample Size		No Influence	Slight Influence	Some Influence	Moderate Influence	A Great Deal Of Influence
How Much Influence Do Teachers Have On Policy	484		38 (7.9%)	84 (17.4%)	153 (31.6%)	123 (25.4%)	86 (17.8%)

Table 4.37: Fifth-Grade Departmentalized Mathematics Teachers' Control Over Curriculum

Variable	Sample Size		No Control	Slight Control	Some Control	Moderate Control	A Great Deal Of Control
How Much Do Teachers Control Curriculum	484		4 (0.8%)	19 (3.9%)	60 (12.4%)	139 (28.7%)	262 (54.1%)

The next set of variables analyzed teachers' beliefs and concerns about their job. These results are shown in tables 4.38 and 4.39, with the significant differences indicated. One significant difference was that approximately 43.5% of self-contained teachers strongly indicated that they enjoy their present teaching job, whereas more than half (almost 55%) of team teachers strongly indicated this. Another significant difference was that about one fifth of self-contained teachers strongly agreed that there is agreement regarding the school mission compared to slightly more than a quarter of departmentalized teachers.

Also, slightly more than a third of self-contained teachers strongly agreed that school administration encourages staff, yet more than 40% of departmentalized teachers strongly agreed with this. Furthermore, approximately 42% of both departmentalized teachers and self-contained teachers strongly agreed that they would choose teaching again as a career. On the other hand, more than half of team teachers strongly agreed that they would choose teaching again as a career. Finally, almost 57% of self-contained teachers agreed or strongly agreed that they are satisfied with the size of their class as compared to almost 66% of departmentalized teachers.

Table 4.38: Fifth-Grade Departmentalized Mathematics Teachers' Beliefs and Concerns about Their Job I

Variable	Sample Size		Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
Academic Standards Too Low	484		207 (42.8%)	193 (39.9%)	52 (10.7%)	31 (6.4%)	1 (0.2%)
Teacher Enjoys Present Teaching Job*	483		1 (0.2%)	20 (4.1%)	27 (5.6%)	216 (44.7%)	219 (45.3%)
Teacher Makes Difference in Children's Lives	482		0 (0%)	5 (1.0%)	35 (7.3%)	237 (49.2%)	205 (42.5%)
Staff Accepts Me As Colleague	484		2 (0.4%)	4 (0.8%)	24 (5.0%)	220 (45.5%)	234 (48.4%)
Paperwork Interferes With Teaching	484		24 (5.0%)	113 (23.4%)	118 (24.4%)	163 (33.7%)	66 (13.6%)
Parents Support School Staff	483		10 (2.1%)	42 (8.7%)	102 (21.1%)	284 (58.8%)	45 (9.3%)
Children Not Capable of Learning	485		137 (28.3%)	226 (46.6%)	52 (10.7%)	57 (11.8%)	13 (2.7%)
Child Misbehavior Affects Teaching	484		104 (21.5%)	200 (41.3%)	80 (16.5%)	67 (13.8%)	33 (6.8%)
Agreement Exists By Faculty About School Mission*	485		1 (0.2%)	35 (7.2%)	70 (14.4%)	251 (51.8%)	128 (26.4%)
School Administration Communicates Vision	485		5 (1.0%)	24 (5.0%)	59 (12.1%)	223 (46.0%)	174 (35.9%)

*indicates a significant difference at $\alpha = 0.05$

Table 4.39: Fifth-Grade Departmentalized Mathematics Teachers' Beliefs and Concerns about Their Job II

Variable	Sample Size		Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
School Administration Handles Outside Pressure	485		8 (1.7%)	37 (7.6%)	87 (17.9%)	208 (42.9%)	145 (29.9%)
School Administration Prioritizes Well	485		6 (1.2%)	23 (4.7%)	66 (13.6%)	246 (50.7%)	144 (29.7%)
School Administration Encourages Staff*	483		12 (2.5%)	26 (5.4%)	55 (11.4%)	192 (39.8%)	198 (41.0%)
Student Physical Conflicts Are A Serious Problem	484		150 (31.0%)	208 (43.0%)	75 (15.5%)	37 (7.6%)	14 (2.9%)
Staff Seeks/Learns New Ideas	484		3 (0.6%)	15 (3.1%)	53 (11.0%)	250 (51.7%)	163 (33.7%)
Children Bullying Other Children Is A Serious Problem	483		74 (15.3%)	196 (40.6%)	129 (26.7%)	65 (13.5%	19 (3.9%)
Would Choose Teaching Again As A Career*	482		12 (2.5%)	37 (7.7%)	63 (13.1%)	170 (35.3%)	200 (41.5%)
Teacher Is Satisfied With Class Size*	480		29 (6.0%)	93 (19.4%)	40 (8.3%)	191 (39.8%)	127 (26.5%)
Teacher Is Concerned About Job Security Due To State/Local Tests	482		135 (28.0%)	184 (38.2%)	88 (18.3%)	57 (11.8%)	18 (3.7%)

* indicates a significant difference at α = 0.05

Next, variables pertaining to the teaching practices of fifth-grade departmentalized teachers were analyzed, and the results are provided in tables 4.40 through 4.47. Five significant differences were found, with the first being that almost 7% of departmentalized teachers used a VCR at least once a week as compared to 13% of self-contained teachers, and that about 42% of team teachers used a VCR two or three times a month whereas 28% of departmentalized teachers did. In addition, about 24% of both self-contained and team teachers never had students use the computer or at most, just once a month. However, this was the case for more than a third (34%) of departmentalized teachers. Moreover, almost half of self-contained teachers indicated they usually integrate two areas of the curriculum, if not all the time, as compared to 41% of team teachers and 30% of departmentalized teachers who indicated this. The approximately 82% of departmentalized teachers who did not have aides was significantly higher than the 72.7% of self-contained teachers who did not have aides. Lastly, roughly 36% of team teachers and 32% of departmentalized teachers were found to have at least 60 minutes a day of mathematics, whereas almost 43% of self-contained teachers were found to have at least 60 minutes of mathematics per day.

Table 4.40: Fifth-Grade Departmentalized Mathematics Teachers' Standardized Test Preparation Time

Variable	Sample Size		Mean	Standard Deviation	Minimum	Maximum
Hours Spent Preparing Class For Standardized Tests	352		12.4	15.9	0	90

Table 4.41: Fifth-Grade Departmentalized Mathematics Teachers' Frequency of Technology Use

Variable	Sample Size	Never	Once A Month Or Less	2 Or 3 Times A Month	1 or 2 Times A Week	3 or 4 Times A Week	Daily
Frequency Use Of VCR*	411	62 (15%)	185 (45.0%)	133 (32.4%)	25 (6.0%)	3 (0.7%)	3 (0.7%)
Frequency Use Of TV Programs	339	157 (46.3%)	110 (32.4%)	17 (5.0%)	19 (5.6%)	2 (0.6%)	34 (10%)
Frequency Of Student Computer Use*	469	56 (11.9%)	98 (20.9%)	143 (30.5%)	110 (23.5%)	39 (8.3%)	23 (4.9%)

*indicates a significant difference at $\alpha = 0.05$

Table 4.42: Fifth-Grade Departmentalized Mathematics Teachers' Frequency of Mathematics

Variable	Sample Size	Less Than Once A Week	Once Or Twice A Week	Three Or Four Times A Week	Daily
How Often Is Mathematics – Lessons, In Group, etc.	485	3 (0.6%)	7 (1.4%)	24 (5.0%)	451 (93.0%)

Table 4.43: Fifth-Grade Departmentalized Mathematics Teachers' Frequency of Integrating Curricula

Variable	Sample Size	Never	Occasionally	Usually	All The Time
How Often Do You Integrate Curricula*	479	30 (6.3%)	309 (64.5%)	121 (25.3%)	19 (4.0%)

Table 4.44: Fifth-Grade Departmentalized Mathematics Teachers' Expectations of Homework

Variable	Sampl e Size	None	10 Minutes	20 Minutes	30 Minutes	More Than 30 Minutes
Amount of Time Expected For Homework By Students Daily	485	13 (2.7%)	56 (11.6%)	238 (49.1%)	143 (29.5%)	35 (7.2%)

Table 4.45: Fifth-Grade Departmentalized Mathematics Teachers' Number of Aides

Variable	Sample Size		0	1	2	3	4
Number Of Regular Paid Aides Per Week*	453		367 (81.0%)	71 (15.7%)	12 (2.7%)	2 (0.4%)	1 (0.2%)

*indicates a significant difference at α = 0.05

Table 4.46: Fifth-Grade Departmentalized Mathematics Teachers' Aides' Education Level

Variable	Sample Size		H.S. Diploma Or GED	Associate's Degree	Bachelor's Degree Or Higher	Don't Know	No Paid Aides In Classroom
Highest Education Level of Paid Aide	463		77 (16.6%)	29 (6.3%)	68 (14.7%)	47 (10.2%)	242 (52.3%)

Table 4.47: Fifth-Grade Departmentalized Mathematics Teachers' Time for Mathematics Class

Variable	Sample Size		1-30 Minutes A Day	31-60 Minutes A Day	61-90 Minutes A Day	More Than 90 Minutes A Day
Time For Mathematics in Class*	466		22 (4.7%)	301 (64.6%)	115 (24.7%)	28 (6.0%)

*indicates a significant difference at α = 0.05

The last set of variables analyzed pertains to certain aspects of the teacher's job that occur outside of the classroom. The results are shown in Tables 4.48 and 4.49. Four significant differences were revealed, with the first significant difference being that almost a third of team teachers meet at least three times a week for lesson planning, yet 16% of self-contained teachers and 16.2% of departmentalized teachers meet at least three times weekly for lesson planning. Also found, was that less than 2% of self-contained and departmentalized teachers met daily to discuss curricula, whereas almost 6% of team teachers did. The next significant difference revealed that about 5% of self-contained teachers met daily to discuss a child as compared to 14.5% of team teachers and 11% of departmentalized teachers. And finally, approximately a third of self-contained teachers found the teaching of mathematics activities provided very useful, whereas 46% of team teachers, and 45% of departmentalized teachers found this.

Table 4.48: Fifth-Grade Departmentalized Mathematics Teachers' Frequency Of Meeting Times Outside Of Class

Variable	Sample Size		Never	Once A Month Or Less	2 Or 3 Times A Month	1 or 2 Times A Week	3 or 4 Times A Week	Daily
Times Meet For Lesson Planning*	483		32 (6.6%)	92 (19.1%)	98 (20.3%)	181 (37.5%)	47 (9.7%)	33 (6.8%)
Times Meet To Discuss Curriculum*	483		22 (4.6%)	206 (42.7%)	141 (29.2%)	90 (18.6%)	16 (3.3%)	8 (1.7%)
Times Meet To Discuss A Child*	484		2 (0.4%)	84 (17.4%)	120 (24.8%)	165 (34.1%)	59 (12.2%)	54 (11.2%)

*indicates a significant difference at $\alpha = 0.05$

Table 4.49: How Useful Fifth-Grade Departmentalized Mathematics Teachers Find Mathematics Activities

Variable	Sample Size		Not At All Useful	Slightly Useful	Moderately Useful	Very Useful
Usefulness Of Teaching Of Mathematics Or Mathematics Activities*	352		4 (1.1%)	47 (13.4%)	142 (40.3%)	159 (45.2%)

*indicates a significant difference at $\alpha = 0.05$

Tables 4.50 through 4.54 show what fifth-grade teacher variables resulted in a significant difference. Although three groups were compared, many of the significant differences were due to differences between one or two pairs of the teacher groups. Therefore, in addition to listing the variables that resulted in a significant difference, tables 4.50 through 4.54 also list the pairwise significant differences and explain what the significant difference is. (In tables 4.50 through 4.54, the following are used: SC – self-contained teachers, TT – team teachers, Dep. – departmentalized teachers)

Table 4.50: Fifth-Grade Teacher Background Variables Where A Significant Difference Is Present

Significantly Different 5th Grade Variable	Pairwise Comparison			Significant Difference Explanation
	SC vs. Dep.	TT vs. Dep.	SC vs. TT	
Number Of Years Teaching 5th Grade	x			Self-contained teachers have a mean of 6.5 years whereas departmentalized teachers have a mean of 7.1 years of teaching 5th grade.
Undergraduate Degree in Mathematics	x	x		4.9% of self-contained teachers and 4.5% of team teaching teachers have an undergraduate degree in mathematics compared to 9.7% of departmentalized teachers.
Undergraduate Degree in Mathematics Education	x			4.1% of self-contained teachers have a degree in mathematics education, compared to 7.3% of departmentalized teachers.
Undergraduate Degree in Elementary Education			x	70.3% of self-contained teachers have an undergraduate degree in elementary education as compared to 80% of team teachers.
Certification in Elementary Education	x			About 87% of departmentalized teachers are certified in elementary education, whereas almost 97% of self-contained teachers are.
Certification in Elementary Mathematics	x			Approximately 38% of departmentalized teachers are certified to teach elementary mathematics as compared to approximately 32% of self-contained teachers.
Number of Hours Participating in Mathematics Workshops in the Past Year	x			In the previous year, self-contained teachers participated in 8.7 hours of mathematics workshops, whereas departmentalized teachers participated 12.3 hours.
Certification in Middle/Junior High/Secondary Mathematics	x	x		About 9% of self-contained teachers and 11% of team teachers had middle/secondary mathematics certification, yet more than 18% of departmentalized teachers had this certification.

Table 4.51 Fifth-Grade Teacher Beliefs and Concerns Variables Where A Significant Difference Is Present

Significantly Different 5th Grade Variable	**Pairwise Comparison** SC vs. Dep.	**Pairwise Comparison** TT vs. Dep.	**Pairwise Comparison** SC vs. TT	**Significant Difference Explanation**
Agreement Exists By Faculty About School Mission	x			About one fifth of self-contained teachers strongly agree that there is agreement regarding the school mission compared to slightly more than a quarter of departmentalized teachers.
Teacher Enjoys Present Teaching Job			x	Approximately 43.5% of self-contained teachers strongly indicated that they enjoy their present teaching job, whereas more than half (almost 55%) of team teachers strongly indicated this.
School Administration Encourages Staff	x			Slightly more than a third of self-contained teachers strongly agree that school administration encourages staff, yet more than 40% of departmentalized teachers strongly agree with this.
Would Choose Teaching Again As A Career		x	x	Approximately 42% of departmentalized teachers and also self-contained teachers strongly agree that they would choose teaching again as a career. On the other hand, more than half of team teachers strongly agree that they would choose teaching again as a career.
Teacher Is Satisfied With Class Size	x			Almost 57% of self-contained teachers agree or strongly agree that they are satisfied with the size of their class as compared to almost 66% of departmentalized teachers.

Table 4.52: Fifth-Grade Teacher Assessment And Evaluation Variables Where A Significant Difference Is Present

Significantly Different 5th Grade Variable	Pairwise Comparison			Significant Difference Explanation
	SC vs. Dep.	TT vs. Dep.	SC vs. TT	
How Often State/Local Standardized Tests Are Given			x	Approximately 6% of self-contained teachers give state/local standardized tests at least once or twice a week, whereas less than 3% of team teachers do.
How Often Teacher-Made Tests Or Quizzes Are Given	x	x		Teacher-made tests/quizzes are given 3 – 4 times a week by 11.4% of self-contained teachers, 9.3%, of team teachers, and 3.5% of departmentalized teachers.
How Often Textbook Chapter-End Tests Are Given	x		x	Textbook chapter-end tests are given at least once or twice a week by 43.7% of self-contained teachers, 31.6%, of team teachers, and 25.3% of departmentalized teachers.
Frequency Of Individual Or Group Projects	x	x		Projects are given at least once or twice a week by 19.1% of self-contained teachers, 17.6%, of team teachers, and about 14% of departmentalized teachers.
Frequency Of Work Samples			x	Slightly more than 34% of self-contained teachers give work samples three or four times a week as compared to 27% of team teachers.
Usefulness Of Standardized Test Scores	x			Slightly more than 43% of departmentalized teachers find standardized test scores either very or extremely useful, as compared to 35.1% of self-contained teachers.

Table 4.53 Fifth-Grade Teacher Teaching Practices Variables Where A Significant Difference Is Present

Significantly Different 5th Grade Variable	Pairwise Comparison			Significant Difference Explanation
	SC vs. Dep.	TT vs. Dep.	SC vs. TT	
Frequency The Child Uses A Computer For Mathematics	x	x		About 24% of both self-contained and team teachers never have students use the computer or at most, just once a month. However, this is the case for more than a third (34%) of departmentalized teachers.
Frequency A VCR Is Used In The Classroom	x	x		Almost 7% of departmentalized teachers use a VCR at least once a week as compared to 13% of self-contained teachers. Also, about 42% of team teachers use a VCR two or three times a month whereas only 28% of departmentalized teachers do.
Number of Paid Aides That Help Class Per Week	x			Approximately 82% of departmentalized teachers do not have aides, compared to 72.7% of self-contained teachers who do not have aides.
Amount Of Time For Mathematics In Class	x		x	Almost 43% of self-contained teachers have at least 60 minutes per day of mathematics whereas almost 36% of team teachers and 32% of departmentalized teachers have at least 60 minutes a day.
Integrate Two Areas Of the Curriculum	x	x	x	Almost half of self-contained teachers indicated they usually integrate two areas of the curriculum, if not all the time, as compared to 41% of team teachers and 30% of departmentalized teachers who indicated this.

4.54 Fifth-Grade Teacher Outside The Classroom Variables Where A Significant Difference Is Present

Significantly Different 5th Grade Variable	**Pairwise Comparison**			**Significant Difference Explanation**
	SC vs. Dep.	**TT vs. Dep.**	**SC vs. TT**	
Usefulness Of Teaching Of Mathematics Or Mathematics Activities	x		x	Approximately a third of self-contained teachers found the teaching of mathematics activities provided very useful, as did 46% of team teachers, and 45% of departmentalized teachers.
Times Meet To Discuss Curriculum		x	x	Less than 2% of self-contained and departmentalized teachers meet daily to discuss curricula, whereas almost 6% of team teachers do.
Times Meet To Discuss A Child	x		x	About 5% of self-contained teachers meet daily to discuss a child as compared to 14.5% of team teachers and 11% of departmentalized teachers.
Amount Of Times Meet For Lesson Planning		x	x	Almost a third of team teachers meet at least three times a week, whereas 16% of self-contained teachers and 16.15% of departmentalized teachers meet at least three times weekly for lesson planning.

Third-Grade Student Mathematics Proficiency Comparison

To examine the mathematics proficiency gained by third-grade students, the first-grade IRT scores were subtracted from the third-grade IRT scores resulting in the mathematics proficiency gained from first to third grade. After eliminating missing and erroneous data, the IRT proficiency gains of the self-contained third-grade students were compared to the IRT proficiency gains of the departmentalized third-grade students with a t-test. This resulted in no significant difference of the gains as is shown in Table 4.56. However, further analysis revealed that there was a significant difference in the baseline first-grade IRT mean with the departmentalized group already having a significantly higher mean, as can be seen in Table 4.55. Thus, these results are inconclusive, since the self-contained and departmentalized students already began with a significant difference.

To rectify the problem of the baseline groups already having a significant difference, a subset of students whose first-grade mean IRT scores centered around the average IRT mean score of 62.3 were compared. This allowed for there to be no significant difference in IRT scores among the baseline groups. The analysis resulted in there being no significant difference in mathematics proficiency between the self-contained and departmentalized third graders with similar first grade scores as shown in Tables 4.57 and 4.58.

Table 4.55 All Third-Grade Students' Mean IRT Scores By Grade Level

All Third-Grade Students		First- Grade IRT Mean	Third- Grade IRT Mean	Fifth-Grade IRT Mean	Eighth-Grade IRT Mean
Self-Contained		62.2	99.5	124.6	142.8
Departmentalized		64.1	101.8	126.9	143.8
Difference		1.9*	2.3*	2.3*	1.0
ρ − value		0.0004	0.0008	0.002	0.1223

* indicates a significant difference at α = 0.05

Table 4.56 Longitudinal Mathematics Proficiency IRT Gains Of All Third-Grade Students

All Third-Grade Students		IRT Gain In Mathematics Proficiency From First To Third Grade	IRT Gain In Mathematics Proficiency From First To Fifth Grade	IRT Gain In Mathematics Proficiency From First To Eighth Grade
Self-Contained		37.6	62.1	79.3
Departmentalized		37.9	62.7	78.9
Difference		0.3	0.6	0.4
ρ − value		0.2413	0.1271	0.7187

Table 4.57 IRT Scores By Grade Level Of Third-Grade Students With the Same Baseline Mean

Third-Grade Students With The Same Baseline Mean		First- Grade IRT Mean	Third- Grade IRT Mean	Fifth-Grade IRT Mean	Eighth-Grade IRT Mean
Self-Contained		62.3	102.6	128.4	144.4
Departmentalized		62.3	98.7	131.0	146.1
Difference		0	3.9	2.6	1.7
ρ − value		0.5082	0.9681	0.1312	0.2382

Table 4.58 Longitudinal IRT Mathematics Proficiency Gains Of Third-Grade Students With the Same Baseline Mean

Third-Grade Students With The Same Baseline Mean		IRT Gain In Mathematics Proficiency From First To Third Grade	IRT Gain In Mathematics Proficiency From First To Fifth Grade	IRT Gain In Mathematics Proficiency From First To Eighth Grade
Self-Contained		40.7	66.1	82.1
Departmentalized		37.7	68.7	83.8
Difference		3.0	2.6	1.7
ρ − value		0.9290	0.1320	0.2323

The researcher then compared the mathematics proficiency gains of the third-grade students who had teachers with below-average mathematics backgrounds. Teachers with below-average mathematics backgrounds are those who have taken less than the average number of mathematics methods courses in college and those who have participated in less than the average number of mathematics workshop hours in the past year. The averages used for the third-grade teachers were 2.8 mathematics methods courses and 7.95 mathematics workshop hours as these are the mean number of mathematics methods courses and mathematics workshop hours of all 4,180 third-grade teachers in the ECLS-K data set.

As shown in Table 4.59, the baseline groups did not have a significant difference between them, which is ideal for the analysis. The comparison resulted in a significant difference ($\rho = 0.0054$) between the self-contained and departmentalized students, with the departmentalized students achieving a higher gain. The departmentalized students improved by 39.3 points while the self-contained students improved by 37.4 points on the IRT mathematics proficiency scale.

Without taking into consideration fifth-grade classroom organization, this significant difference in proficiency gain among the students of the below-average mathematics third-grade teachers continued into the fifth grade ($\rho = 0.002$). Between the first and fifth grades, the departmentalized students gained approximately 64.6 points in mathematics proficiency as compared to the self-contained students who only gained 62 points.

In the eighth grade, the significant difference no longer exists, as the p-value is slightly higher than 0.05 ($\rho = 0.0779$). The departmentalized students of teachers who have below-average mathematics backgrounds gained approximately 80.5 points from the first grade to the eighth grade on the IRT mathematics proficiency scale, whereas the self-contained students gained 79.1 points, as shown in Table 4.60. Since the difference found at the eighth-grade level was almost significant, students were then compared to see if the departmentalized group, the group with the higher gain in improvement, was more likely to end up in higher-level eighth-grade mathematics courses. This analysis yielded no significant difference.

Table 4.59 Summary Of IRT Scores Of Third-Grade Students Of Teachers With a Below-Average Mathematics Background

Third-Grade Students Of Teachers with Weak Mathematics Background		First-Grade Mean Proficiency Score (Baseline)	Third-Grade Mean Proficiency Score	Fifth-Grade Mean Proficiency Score	Eighth-Grade Mean Proficiency Score
Self-Contained		63.1	100.1	125.5	143.5
Departmentalized		63.7	103.2	128.1	144.3
Difference		0.6	3.1*	2.6*	0.8
ρ − value		0.2479	0.0035	0.0221	0.262

* indicates a significant difference at $\alpha = 0.05$

Table 4.60 Longitudinal IRT Gains Of Third-Grade Students Of Teachers With a Below-Average Mathematics Background

Third-Grade Students Of Teachers with Weak Mathematics Background	IRT Gain In Mathematics Proficiency From First To Third Grade	IRT Gain In Mathematics Proficiency From First To Fifth Grade	IRT Gain In Mathematics Proficiency From First To Eighth Grade
Self-Contained	37.4	62.0	79.1
Departmentalized	39.3	64.6	80.5
Difference	1.9*	2.6*	1.4
ρ − value	0.0054	0.002	0.0779

* indicates a significant difference at $\alpha = 0.05$

Fifth-Grade Student Mathematics Proficiency Comparison

To examine the mathematics proficiency gained by fifth-grade students, the first-grade IRT scores were subtracted from the fifth-grade IRT scores. This resulted in the mathematics proficiency gained from first to fifth grade. The fifth grade students were then separated into six groups based on their classroom organization in the third and fifth grades. The six groups were the following:

- Self-Contained – Self-Contained
- Self-Contained – Team Teaching
- Self-Contained – Departmentalized
- Departmentalized – Self-Contained
- Departmentalized – Team Teaching
- Departmentalized – Departmentalized

After eliminating missing and erroneous data at the fifth-grade level, the IRT proficiency gains of the six groups were compared to one another using ANOVA (Table 4.62). A significant difference between the mathematics proficiency gains was found, and the corresponding p-value was 0.0005. To determine if there was a significant difference in the eighth grade, an analysis using ANOVA was conducted on these same six groups comparing the mathematics proficiency gain from first to eighth grade. No significant difference was found, but the p-value was only slightly outside the range of significance at 0.0504. Since the difference found at the eighth-grade level was almost significant, groups were then compared to determine if there was a relationship between gain and higher-level eighth-grade mathematics courses. This analysis yielded no conclusive results.

Since there was already a significant difference between the IRT means of the groups at first grade, as shown in Table 4.61, it was not possible to reach a conclusion regarding the gains in mathematics proficiency. To alleviate the problem of the baseline groups already having a significant difference, a subset of students whose first-grade IRT scores centered around the average IRT mean score of 62.9 were compared. This allowed for there to be no significant different among the baseline groups. The analysis resulted in there being no significant difference in mathematics proficiency among any of the six groups as shown in Tables 4.63 and 4.64.

Table 4.61: All Fifth-Grade Students' Mean IRT Scores By Grade Level

Third Grade – Fifth Grade Group		First-Grade IRT Mean		Fifth-Grade IRT Mean	Eighth-Grade IRT Mean
Self-Contained – Self-Contained		62.2[a]		124.6[a]	143.2
Self-Contained – Team Teaching		63.9		126.5	143.7
Self-Contained – Departmentalized		63.3		124.0[b]	142.7
Departmentalized – Self-Contained		61.9[b]		125.5	142.5
Departmentalized – Team Teaching		65.6		129.8[ab]	144.7
Departmentalized – Departmentalized		66.0[ab]		126.8	144.8
ρ — value		0.0000		.0013	0.5078

a indicates a pairwise significant difference at $\alpha = 0.05$
b indicates a pairwise significant difference at $\alpha = 0.05$

Table 4.62: Gain In Mathematics Proficiency Comparison Of All Fifth-Grade Students

Third Grade – Fifth Grade		Gain In Mathematics Proficiency (From First to Fifth Grade)	Gain In Mathematics Proficiency (From First to Eighth Grade)
Self-Contained – Self-Contained		62.5[a]	79.8
Self-Contained – Team Teaching		62.8	79.2
Self-Contained – Departmentalized		61.0[a]	78.7
Departmentalized – Self-Contained		63.7	80.6
Departmentalized – Team Teaching		64.5	79.0
Departmentalized – Departmentalized		60.9	77.5
ρ — value		0.0005	.0504

a indicates a pairwise significant difference at $\alpha = 0.05$

Table 4.63 IRT Scores By Grade Level Of Fifth-Grade Students With the Same Baseline Mean

Third Grade – Fifth Grade Group		First-Grade IRT Mean	Fifth-Grade IRT Mean	Eighth-Grade IRT Mean
Self-Contained – Self-Contained		62.9	129.9	146.8
Self-Contained – Team Teaching		62.9	127.4	143.5
Self-Contained – Departmentalized		62.9	126.7	144.1
Departmentalized – Self-Contained		62.9	130.3	147.0
Departmentalized – Team Teaching		63.1	133.9	146.0
Departmentalized – Departmentalized		62.9	126.7	145.6
ρ — value		0.9440	0.3706	0.6176

Table 4.64 Longitudinal IRT Gains Of Fifth-Grade Students Of Teachers With a Weak Mathematics Background

Third Grade – Fifth Grade Groups		First to Fifth Grade Gain In Mathematics Proficiency	First to Eighth Grade Gain In Mathematics Proficiency
Self-Contained – Self-Contained		66.9	83.9
Self-Contained – Team Teaching		64.5	80.6
Self-Contained – Departmentalized		63.7	81.2
Departmentalized – Self-Contained		67.3	84.0
Departmentalized – Team Teaching		70.8	82.9
Departmentalized – Departmentalized		63.9	82.8
ρ — value		0.3821	0.6303

The researcher then compared the mathematics proficiency gains of the fifth-grade students who had teachers with below-average mathematics backgrounds at both the third-grade and fifth-grade levels. Fifth-grade teachers with below-average mathematics backgrounds were those who had:

- not earned an undergraduate mathematics degree
- not earned an undergraduate mathematics education degree
- not earned a graduate mathematics degree
- not earned a graduate mathematics education degree

- taken less than 2.6 college mathematics methods courses
- attended less than 9.6 hours of mathematics workshops in the past year

The averages of 2.6 mathematics methods courses and 9.6 mathematics workshop hours were used since these are the mean number of mathematics methods courses and mathematics workshop hours of all 2,204 fifth-grade teachers in the ECLS-K data set.

After eliminating missing and erroneous data at the fifth-grade level, the IRT proficiency gains of the six groups were compared to one another using ANOVA. As shown in Table 4.65, the baseline groups did have a significant difference between them ($\rho = 0.0455$), yet an analysis of the first to fifth-grade gains did result in an overall significant difference ($\rho = 0.0146$) and a pairwise significant difference between the self-contained–departmentalized group and the departmentalized-departmentalized group ($\rho = 0.03$) as shown in Table 4.66.

This significant difference in proficiency gains between the groups when comparing students of teachers with below-average mathematics backgrounds continued in eighth grade with an overall ρ-value of 0.007. There was also a pairwise significant difference between the self-contained–self-contained group and the self-contained–team teaching group ($\rho = 0.05$). Since a significant difference was found at the eighth-grade level amongst the gains and means, an analysis was done to determine if students in the departmentalized-departmentalized group, the group with the highest eighth-grade IRT mean, was more likely to end up in higher-level eighth-grade mathematics courses. This analysis yielded no results of statistical significance.

Table 4.65 Summary of IRT Scores of Fifth-Grade Students of Teachers with a Below-

Average Mathematics Background

Third Grade – Fifth Grade Group		First-Grade IRT Mean	Fifth-Grade IRT Mean	Eighth-Grade IRT Mean
Self-Contained – Self-Contained		63.9	127.0[a]	145.8
Self-Contained – Team Teaching		66.0	128.5	143.4
Self-Contained – Departmentalized		65.3	126.6	146.3
Departmentalized – Self-Contained		58.9	123.8[b]	141.3
Departmentalized – Team Teaching		62.7	129.6	136.1
Departmentalized – Departmentalized		67.6	136.8[ab]	150.7
ρ — value		0.0455	0.0395	0.0365

a indicates a pairwise significant difference at $\alpha = 0.05$
b indicates a pairwise significant difference at $\alpha = 0.05$

Table 4.66: Gain in Mathematics Proficiency Comparison of Fifth-Grade Students Of Teachers With Weak Mathematics Backgrounds

Third Grade – Fifth Grade		Gain In Mathematics Proficiency (From First to Fifth Grade)	Gain In Mathematics Proficiency (From First to Eighth Grade)
Self-Contained – Self-Contained		63.3	80.8[b]
Self-Contained – Team Teaching		62.3	76.4[b]
Self-Contained – Departmentalized		61.4[a]	79.4
Departmentalized – Self-Contained		64.8	83.2
Departmentalized – Team Teaching		67.7	73.0
Departmentalized – Departmentalized		68.8[a]	82.0
ρ — value		0.0146	0.0070

a indicates a pairwise significant difference at $\alpha = 0.05$
b indicates a pairwise significant difference at $\alpha = 0.05$

The results from the third-grade and fifth-grade analyses reveal that at both the third-grade and fifth-grade levels, departmentalization is significant when teachers have a below-average mathematics background. This may be due to the benefits of departmentalization having a stronger positive impact on the teachers with a weaker mathematics background as compared to teachers who have a stronger mathematics background. If a teacher is already strong in mathematics, it is likely he or she can provide sound mathematics instruction regardless of the type of classroom organization. However, a teacher who is below average or even weak in mathematics will have much more room for improvement in their mathematical knowledge, which the benefits of departmentalization are likely to provide. Thus, the proficiency comparison results suggest that departmentalization can improve mathematical knowledge of teachers, thereby improving mathematical knowledge of students, when improvement is needed.

Probability Proficiency Scores

While there are statistically significant differences in mathematics proficiency among the students of teachers with below-average mathematical backgrounds, it is necessary to determine if these differences are significant in a practical sense. To determine what these differences mean, what a few points on the IRT proficiency scale could mean, the investigator analyzed the effect of departmentalization on the learning of a particular mathematics topic – fractions. The topic of fractions was selected, because it is one that gives both students and teachers trouble alike, it is a very important topic in mathematics, and the increase in student proficiency of fractions occurred during the third and fifth grades when departmentalization took place.

The probability proficiency score gives the percentage of students that have become proficient in a particular topic. In this instance, the probability proficiency scores of students who had teachers with below-average mathematics backgrounds were analyzed in the first, third, fifth, and eighth grades in the area of fractions. As shown in Table 4.67, in all of the first-grade groups there are essentially 0% of students that are proficient in fractions. The three groups that received departmentalization at the third-grade level all had a higher percentage of students proficient in fractions than any of the three groups that received self-contained instruction. By the eighth grade, the group with the highest proficiency probability score was the departmentalized-departmentalized group. It was the only group where more than half of the students were proficient in fractions.

These results suggest that a few-point difference on the IRT proficiency scale can correspond to a fairly large percentage difference in the student proficiency level on a particular mathematics topic. This is meaningful, because if policy decisions are to be made based on the findings of this research, the results need to be not only statistically significant, but also pragmatically significant.

Table 4.67 Summary of Fraction Proficiency Probability Scores From First to Eighth Grade

Third Grade – Fifth Grade Group		**First-Grade**	**Third-Grade**	**Fifth-Grade**	**Eighth-Grade**
Self-Contained – Self-Contained		0.000006	0.0107	0.1311	0.4613
Self-Contained – Team Teaching		0.000012	0.0132	0.1561	0.4028
Self-Contained – Departmentalized		0.000012	0.0210	0.1461	0.4538
Departmentalized – Self-Contained		0.000042	0.0047	0.0988	0.3783
Departmentalized – Team Teaching		0.000107	0.0244	0.2248	0.2585
Departmentalized – Departmentalized		0	0.0448	0.2580	0.5423
ρ − value		0.0062	0.0050	.00052	0.0601

Regression Models

Since a significant difference of some kind was found in the mathematics proficiency of departmentalized and non-departmentalized students in the third, fifth, and eighth grades, a regression model was created for all students in each of these grades. No model was created for eighth-grade upper-level mathematics course attainment, because no significant difference was found in any instance for upper-level course attainment.

The first regression models, shown in Tables 4.68, 4.69, and 4.70, were created solely with the output variable, mathematics proficiency gain, and the input variable, classroom organization:

$GMP = \alpha + \beta_1 ClsOrg + e_i$

- GMP = gain in mathematics proficiency
- α = constant
- ClsOrg – type of classroom organization
- e_i = root mean square error

A model was created for each grade, and since classroom organization is a categorical variable, dummy variables were used when necessary. Interaction of 3rd grade departmentalization and 5th grade classroom organization was included in the 5th and 8th grade models. The third-grade model reveals that third-grade departmentalization is not significant, and thus the overall model is not significant. However, the fifth- and eighth-grade models contain variables that are significant, making the overall model significant. The models indicate that fifth-grade departmentalization lowers mathematics proficiency gain by approximately one point on the IRT scale, and that at the eighth-grade level, the interaction of third- and fifth-grade departmentalization lowers mathematics proficiency gain by almost three points on the IRT scale. All of the models have very low R-squared values meaning the models have almost no predictive power.

Table: 4.68 Third-Grade Regression Model With Only the Variable Classroom Organization

Variable	Coefficient	p-value
3rd Grade Departmentalization	.235	0.302
R-squared: 0.000 p-value: < 0.303 Root mean square error: 15.172		

Table: 4.69 Fifth-Grade Regression Model With Only the Variable Classroom Organization

Variable	Coefficient	p-value
3rd Grade Departmentalization	1.185	0.106
5th Grade Team Teaching	0.390	0.231
5th Grade Departmentalization*	-1.494	0.001
Interaction Between 3rd Grade Departmentalization and 5th Grade Team Teaching	0.396	0.401
Interaction Between 3rd Grade Departmentalization and 5th Grade Departmentalization	-1.372	0.144
R-squared: 0.003 p-value: < 0.000 Root mean square error: 16.567		

* indicates significance

Table: 4.70 Eighth-Grade Regression Model With Only the Variable Classroom Organization

Variable	Coefficient	p-value
3rd Grade Departmentalization	0.968	0.185
5th Grade Team Teaching	-0.850	0.103
5th Grade Departmentalization*	-1.168	0.013
Interaction Between 3rd Grade Departmentalization and 5th Grade Team Teaching	-0.799	0.331
Interaction Between 3rd Grade Departmentalization and 5th Grade Departmentalization*	-2.738	0.040
R-squared: 0.002 p-value: < 0.021 Root mean square error: 17.609		

* indicates significance

The next set of models aimed to create robust regression models where the resulting models comprised variables of significance and classroom organization variables. To do this, variables in the ECLS-K data set where prior research had shown a strong correlation with mathematics proficiency were selected. These variables, along with the classroom organization variables and variables where significant differences were found among teachers (at the third- and fifth- grade levels), were included as predictors of the gain in mathematics proficiency in the beginning regression model:

$GMP = \alpha + \beta_1 ClsOrg + \beta_1 ClsSz + \beta_1 StCM + \beta_1 StDem + \beta_1 ParInv + \beta_1 ParBck + \beta_1 Socio + \beta_1 PriMath + \beta_1 TchDiff + \beta_1 TchKnow + e_i$

- GMP = gain in mathematics proficiency
- α = constant
- ClsOrg – type of classroom organization
- ClsSz – size of class (Pong & Pallas, 2001)
- StCM – student confidence and motivation
- StDem – student demographic information
- ParInv – parental involvement (Paz, Sheldon & Epstein, Sirvani)
- ParBck – parent background
- Socio – socioeconomic status
- PriMath – prior student mathematical proficiency (Claessens & Engel, 2013)
- TchDiff – significant differences found between third- and fifth-grade teachers
- TchKnow – factors that relate to teacher knowledge
- e_i = root mean square error

First, all missing data were removed. Then, dummy variables were created for all of the variables that were not interval, with the appropriate dummy variables having been omitted to avoid collinearity. After the first analysis of the beginning regression model, using the backward stepwise selection method, the variables with $\rho \geq .05$ were systematically dropped allowing for a reduction in the number of variables used for the final models. Thus, all variables included in the resulting model are statistically significant, with the exception of classroom organization.

The third-grade model shows that departmentalization is not significant. It also shows that students have a higher gain in mathematics proficiency of one to two points when the student's mother is Asian, when teachers have more than zero influence on policy at their school, when teachers use work samples either very little or very often, and when there is a low percentage of Hispanic students in the class.

The model also reveals that students experience one to two points less of a mathematics gain on the IRT scale when students' mothers are American Indian, Alaskan Native, or Hispanic. The mathematics proficiency gain of females is a half-point less than that of males. Also, a student's proficiency in Ordinality and Sequence, Relative Size, Multiplication and Division, and Place Value in kindergarten strongly predict a student's gain in mathematics proficiency between first and third-grade. Altogether, this resulted in a fairly robust model with an r-squared value of 0.4852, meaning it has moderate predictive power. The model and its specific details can be seen in Table 4.71.

Table 4.71 Third-Grade Regression Model After Stepwise Method With Classroom Organization Variable

Variables	Coefficient	p-value
Third-grade departmentalization	0.03	0.1760
Teachers use work samples one or two times a year	1.57	0.0485
Teachers use work samples three or more times a week	1.17	0.0175
Mother is Hispanic	-1.03	0.0475
Mother is Asian	1.42	0.0185
Mother is American Indian or Alaska Native	-1.74	0.0365
Teachers have a slight influence on policy at their school	1.14	0.0399
Teachers have some influence on policy at their school	1.44	0.0074
Teachers have moderate influence on policy at their school	1.43	0.0085
Teachers have a great deal of influence on policy at their school	1.73	0.0023
Student is a female	-0.53	0.0408
The percentage of Hispanic students in the class is between 1% and 5%	1.39	0.0012
The percentage of Hispanic students in the class is between 10% and 25%	1.09	0.0068
The student's IRT score at the end of kindergarten	-0.53	0.0000
The student's proficiency in Ordinality and Sequence upon entering kindergarten	5.95	0.0000
The student's proficiency in Relative Size by the end of kindergarten	11.43	0.0000
The student's proficiency in Multiplication and Division by the end of kindergarten	18.79	0.0000
The student's proficiency in Place Value by the end of kindergarten	32.80	0.0000
R-squared: 0.4852 p-value: < 0.000 Root mean square error: 10.717		

The final third-grade regression model, shown in Table 4.72, consists of only significant variables. Therefore, all of the variables in the prior model are included except for classroom organization. The coefficients and p-values, for the most part, remain the same, yielding the same predictive power as the prior model.

Table 4.72 Final Third-Grade Regression Model Of Only Statistically Significant Variables

Variables	Coefficient	p-value
Teachers use work samples one or two times a year	1.57	0.0485
Teachers use work samples three or more times a week	1.17	0.0175
Mother is Hispanic	-1.03	0.0505
Mother is Asian	1.43	0.0188
Mother is American Indian or Alaska Native	-1.74	0.0385
Teachers have a slight influence on policy at their school	1.14	0.0399
Teachers have some influence on policy at their school	1.44	0.0074
Teachers have moderate influence on policy at their school	1.43	0.0085
Teachers have a great deal of influence on policy at their school	1.73	0.0023
Student is a female	-0.56	0.0468
The percentage of Hispanic students in the class is between 1% and 5%	1.39	0.0012
The percentage of Hispanic students in the class is between 10% and 25%	1.09	0.0071
The student's IRT score at the end of kindergarten	-0.53	0.0000
The student's proficiency in Ordinality and Sequence upon entering kindergarten	5.95	0.0000
The student's proficiency in Relative Size by the end of kindergarten	11.43	0.0000
The student's proficiency in Multiplication and Division by the end of kindergarten	18.79	0.0000
The student's proficiency in Place Value by the end of kindergarten	32.80	0.0000
R-squared: 0.4851 p-value: < 0.000 Root mean square error: 10.717		

The fifth-grade model reveals that departmentalization is not significant. It also demonstrates that teachers enjoying their job, having influence on school policy, and being ambivalent or satisfied with class size leads to a higher mathematics proficiency gain of at least six points and at most 27.44 points on the IRT scale. Students with a perceived interest in mathematics experience a four-point higher mathematics proficiency gain.

The model also reveals that students experience three to thirteen points less of a mathematics gain on the IRT scale if their school is not in the Northeast, if the student is female, and if the student does not engage in Numbers and Operations a lot. Additionally, a student's proficiency in Counting, Numbers, Shapes, and Ordinality and Sequence in kindergarten strongly predict a student's gain in mathematics proficiency between first and fifth-grade. The R-squared value of the model is 0.2622, meaning it does not have strong predictive power. The model and its particulars can be seen in Table 4.73.

Table 4.73 Fifth-Grade Regression Model After Stepwise Method With Classroom Organization Variable

Variable	Coefficient	p-value
Third-grade departmentalization	3.62	0.0880
Fifth-grade team teaching	-1.38	0.2975
Fifth-grade departmentalization	-1.85	0.1730
Teachers agree that they enjoy present teaching job	13.27	0.0165
Teachers strongly agree that they enjoy present teaching job	16.12	0.0050
Teachers have moderate influence on policy at their school	27.00	0.0500
Teachers have a great deal of influence on policy at their school	27.44	0.0470
School is in the Midwest (as compared to the Northeast)	-4.87	0.0085
South (as compared to the Northeast)	-4.61	0.0120
West (as compared to the Northeast)	-5.28	0.0135
Student is a female	-3.48	0.0040
The child engages in Numbers and Operations some (as compared to a lot)	-6.43	0.0065
The child engages in Numbers and Operations a little (as compared to a lot)	-12.55	0.0080
The student's perceived interest in mathematics	4.11	0.0000
Teacher neither agrees nor disagrees about being satisfied with class size	6.89	0.0350
Teacher agrees that he/she is satisfied with class size	6.74	0.0090
Number of students in class	0.60	0.0000
The percentage of minority students in the class is between 10% and 25%	3.93	0.0345
The student's proficiency in Counting, Numbers, and Shapes upon entering kindergarten	16.74	0.0005
The student's proficiency in Ordinality and Sequence by the end of kindergarten	11.9	0.0000
R-squared: 0.2622 p-value: < 0.000 Root mean square error: 15.616		

The final fifth-grade regression model includes only significant variables – all of the variables in the previous model with the exception of classroom organization. The coefficients, p-values, and r-squared value are essentially the same, and the final model and its corresponding details are provided in Table 4.74.

Table 4.74 Final Fifth-Grade Regression Model Of Only Statistically Significant Variables

Variable	Coefficient	p-value
Teachers agree that they enjoy present teaching job	13.14	0.0168
Teachers strongly agree that they enjoy present teaching job	16.12	0.0050
Teachers have moderate influence on policy at their school	27.00	0.0500
Teachers have a great deal of influence on policy at their school	27.44	0.0470
School is in the Midwest (as compared to the Northeast)	-4.87	0.0085
South (as compared to the Northeast)	-4.61	0.0120
West (as compared to the Northeast)	-5.28	0.0135
Student is a female	-3.48	0.0040
The child engages in Numbers and Operations some (as compared to a lot)	-6.43	0.0065
The child engages in Numbers and Operations a little (as compared to a lot)	-12.55	0.0080
The student's perceived interest in mathematics	4.11	0.0000
Teacher neither agrees nor disagrees about being satisfied with class size	6.89	0.0350
Teacher agrees that he/she is satisfied with class size	6.74	0.0090
Number of students in class	0.60	0.0000
The percentage of minority students in the class is between 10% and 25%	3.93	0.0345
The student's proficiency in Counting, Numbers, and Shapes upon entering kindergarten	16.74	0.0005
The student's proficiency in Ordinality and Sequence by the end of kindergarten	11.9	0.0000
R-squared: 0.2483 p-value: < 0.000 Root mean square error: 15.713		

As with the third and fifth-grade models, the eighth-grade model also reveals that departmentalization is not significant. There are results similar to those of the third- and fifth-grade models as well. A student's mathematics proficiency in kindergarten is significant in predicting later mathematics proficiency gain and the higher the proficiency in kindergarten, the higher the proficiency gain later on. Teacher influence on policy and student interest in mathematics have a positive effect on mathematics proficiency gain. If a school is not located in the Northeast, this tends to lead to less of a mathematics proficiency gain for students than if the school had been in the Northeast.

New findings include students having a tutor for mathematics leading to a higher gain in mathematics proficiency, and mother's education level and total number in household having a positive relationship with mathematics proficiency. Overall, though, this eighth-grade model, shown in Table 4.75, has an r-squared value of just 15.279, meaning it has low predictive power.

Table 4.75 Eighth-Grade Regression Model After Stepwise Method With Classroom Organization Variable

Variable	Coefficient	p-value
Third-grade departmentalization	-0.251	0.2995
Fifth-grade team teaching	-1.452	0.1495
Fifth-grade departmentalization	0.269	0.3810
Student had a tutor for mathematics	3.97	0.0000
Teachers have a slight influence on policy at their school (as compared to no influence)	4.67	0.0047
Teachers have some influence on policy at their school (as compared to no influence)	3.49	0.0245
Teachers have moderate influence on policy at their school (as compared to no influence)	6.35	0.0000
Teachers have a great deal of influence on policy at their school (as compared to no influence)	6.95	0.0000
School is in the Midwest (as compared to the Northeast)	-3.95	0.0005
South (as compared to the Northeast)	-6.96	0.0000
West (as compared to the Northeast)	-3.41	0.0140
Total number in household	0.66	0.04
The child engages in Numbers and Operations some (as compared to a lot)	-3.65	0.0270
The child engages in Numbers and Operations a little (as compared to a lot)	-10.56	0.0365
The student's perceived interest in mathematics	1.33	0.0145
The student's IRT score at the beginning of kindergarten	6.89	0.0350
The student's IRT score at the end of kindergarten	6.74	0.0090
Mother earned a high school diploma or the equivalent (as compared to completing only the 8^{th} grade or below)	5.95	0.018
Mother completed a vocational/technical program (as compared to completing only the 8^{th} grade or below)	10.17	0.002
Mother has completed some college (as compared to completing only the 8^{th} grade or below)	8.175	0.003
Mother earned a bachelor's degree (as compared to	9.90	0.0005

completing only the 8th grade or below)		
Mother has attended graduate/professional school (as compared to completing only the 8th grade or below)	9.36	0.0055
Mother has earned a master's degree (as compared to completing only the 8th grade or below)	6.06	0.034
Mother has earned a doctorate or professional degree (as compared to completing only the 8th grade or below)	15.72	0.0000
The student's proficiency in Counting, Numbers, and Shapes upon entering kindergarten	18.03	0.0008
The student's proficiency in Place Value by the end of kindergarten	10.54	0.0000
R-squared: 0.1567 p-value: < 0.000 Root mean square error: 15.279		

The final eighth-grade regression model only includes variables with significant p-values – all of the variables in the prior model with the exception of classroom organization. As before, the coefficients, p-values, and r-squared value are essentially the same, and the final model and its corresponding details are provided in Table 4.76.

Table 4.76 Final Eighth-Grade Regression Model Of Only Statistically Significant Variables

Variable	Coefficient	p-value
Student had a tutor for mathematics	3.97	0.000
Teachers have a slight influence on policy at their school (as compared to no influence)	4.64	0.0045
Teachers have some influence on policy at their school (as compared to no influence)	3.39	0.0235
Teachers have moderate influence on policy at their school (as compared to no influence)	6.35	0.0000
Teachers have a great deal of influence on policy at their school (as compared to no influence)^	6.95	0.0000
School is in the Midwest (as compared to the Northeast)	-3.95	0.0005
South (as compared to the Northeast)	-6.96	0.0000
West (as compared to the Northeast)	-3.41	0.0140
Total number in household	0.66	0.04
The child engages in Numbers and Operations some (as compared to a lot)	-3.65	0.0270
The child engages in Numbers and Operations a little (as compared to a lot)	-10.56	0.0365
The student's perceived interest in mathematics	1.33	0.0145
The student's IRT score at the beginning of kindergarten	6.89	0.0350
The student's IRT score at the end of kindergarten	6.74	0.0090
Mother earned a high school diploma or the equivalent (as compared to completing only the 8th grade or below)	5.95	0.018
Mother completed a vocational/technical program (as compared to completing only the 8th grade or below)	10.07	0.001
Mother has completed some college (as compared to completing only the 8th grade or below)	8.17	0.002
Mother earned a bachelor's degree (as compared to completing only the 8th grade or below)	9.90	0.0005
Mother has attended graduate/professional school (as compared to completing only the 8th grade or below)	9.36	0.0055
Mother has earned a master's degree (as compared to completing only the 8th grade or below)	6.06	0.034
Mother has earned a doctorate or professional degree (as compared to completing only the 8th grade or below)	15.72	0.0000
The student's proficiency in Counting, Numbers, and Shapes upon entering kindergarten	17.91	0.0005
The student's proficiency in Place Value by the end of kindergarten	10.54	0.0000
R-squared: 0.1543 p-value: < 0.000 Root mean square error: 15.276		

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Using the U.S. Department of Education's Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) national data set, departmentalization and its effects on elementary mathematics proficiency were examined. Specifically, analyses were conducted to answer four research questions which focused on the backgrounds of departmentalized teachers, the differences between departmentalized and non-departmentalized teachers, the difference in the mathematical proficiency of departmentalized and non-departmentalized elementary students, and additional factors that may contribute to mathematics proficiency.

Using the statistical software systems, Stata 13 and R, a variety of statistical tests were used to analyze the data: summary statistics, percentage tabulations, t-tests, ANOVA and the post-hoc Bonferroni test, the Kruskal-Wallis test, the Wilcoxon-Mann-Whitney test, Fisher's Exact test, the Chi-Square test, and multiple linear regression. The results of these tests allowed for conclusions to be made regarding departmentalization and its effects, providing useful insight into the circumstances that allow departmentalization to augment the mathematics proficiency of elementary students.

Conclusions

1) ***What are the characteristics of departmentalized elementary mathematics teachers?***

From a sample size of 397 teachers, the average third-grade departmentalized mathematics teacher is approximately 42 years old, has taught for about 14.5 years, nine of which were at their current school and seven of which were at the third-grade level. They have taken a mean of 2.8 mathematics methods courses and participated in 8.6 hours of mathematics workshops in the past year. Approximately 76% of third-grade departmentalized teachers possess the regular or standard state teacher certification, and almost three-quarters have some education beyond a bachelor's degree, with slightly more than a third having a master's degree.

From the more than 450 sampled fifth-grade departmentalized elementary mathematics teachers, the average fifth-grade departmentalized elementary mathematics teacher is approximately 43 years of age, has taken about 2.8 mathematics methods courses and 5.2 elementary methods courses, has been teaching for almost 15 years with eight of those years at the fifth-grade level and 8.5 of those years at their current school. The average fifth-grade departmentalized mathematics teacher is probably not certified to teach elementary mathematics. He or she is also highly unlikely to be certified in middle school or secondary mathematics or to have earned an undergraduate or graduate degree in mathematics or mathematics education. Fifth-grade departmentalized mathematics teachers have participated in roughly 12 hours of mathematics workshops in the past year, and slightly more than a third of them have earned a master's degree.

Overall, the backgrounds of elementary departmentalized mathematics teachers reflect a fairly strong pedagogical and general educational preparation. However, even though these teachers mainly teach mathematics, they tend to lack a strong mathematics background.

2) ***Is there a significant difference in the background and educational characteristics, teaching practices, assessment methods, beliefs, and influence of departmentalized elementary mathematics teachers as compared to self-contained elementary teachers, and if so, what are these differences?***

Self-contained and departmentalized mathematics third-grade teachers were found to be quite similar in their characteristics, teaching practices, evaluation and assessment methods, influence, and beliefs as few significant differences were found between the two groups of teachers. Of the 73 variables analyzed at the third-grade level, only nine variables resulted in a significant difference between the third-grade self-contained and departmentalized mathematics teachers:

- Frequency Of Giving Textbook Chapter-End Tests
- Frequency Of Giving Worksheets
- Frequency Of Giving Work samples
- Teacher Influence On Policy
- If Fellow Teachers Seek/Learn New Ideas
- Frequency Mathematics Textbooks Are Used
- Frequency Students Discuss Real Life Mathematics Problems
- Frequency TV Programs Are Used
- If Achievement Groups For Mathematics are Used

At the fifth-grade level, comparisons were made between self-contained, team, and departmentalized teachers. These three teacher groups were found to be fairly different in their characteristics, teaching practices, evaluation and assessment methods, influence, and beliefs as numerous significant differences were found between the three groups. Out of the 69 variables tested, there were 28 variables that revealed significant differences between the self-contained, team, and departmentalized mathematics teachers:

- Number Of Years Teaching 5th Grade
- Undergraduate Degree in Mathematics
- Undergraduate Degree in Mathematics Education
- Undergraduate Degree in Elementary Education
- Certification in Elementary Education
- Certification in Mathematics Education
- Amount Of Time For Mathematics In Class
- Amount Of Times Meet For Lesson Planning
- Agreement Exists By Faculty About School Mission

- Teacher Enjoys Present Teaching Job
- School Administration Encourages Staff
- Would Choose Teaching Again As A Career
- Teacher Is Satisfied With Class Size
- Integrate Two Areas Of the Curriculum
- State/Local Standardized Tests
- Certification in Middle/Junior High/Secondary School Mathematics
- Frequency Of Teacher-Made Tests Or Quizzes
- Frequency Of Textbook Chapter-End Tests
- Frequency Of Individual Or Group Projects
- Frequency Of Work Samples
- Usefulness Of Standardized Test Scores
- Usefulness Of Teaching Of Mathematics Or Mathematics Activities
- Usefulness Of Standardized Test Scores
- Times Meet To Discuss Curriculum
- Times Meet To Discuss A Child
- Frequency Of Students Computer Use
- Frequency Use Of VCR
- Number Of Paid Aides That Help Class Per Week

3) Is there a significant difference in the mathematical proficiency of elementary students who receive departmentalized classroom instruction as compared to elementary students who receive self-contained classroom instruction, and if so, what other factors contribute to this difference?

When comparing all third-grade students, there is not a significant difference in the mathematical proficiency between the self-contained and departmentalized students. However, a significant difference in mathematical proficiency was found between the third-grade self-contained and departmentalized students of teachers with below-average mathematics backgrounds. A teacher was identified as having a below-average mathematics background if he or she had taken less than 2.8 mathematics methods courses and had participated in less than 7.95 hours of mathematics workshops in the past year. The averages used for the third-grade teachers were 2.8 mathematics methods courses and

7.95 mathematics workshop hours, as these are the mean number of mathematics methods courses and mathematics workshop hours of all 4,180 third-grade teachers in the ECLS-K data set.

In the third grade, students who had departmentalized mathematics teachers with below-average mathematics backgrounds improved significantly more than students who had mathematically below-average teachers in a self-contained setting. Also, regardless of the type of classroom organization these students experienced in the fifth grade, this significant difference of the departmentalized students of mathematically below-average third-grade teachers gaining more in mathematics proficiency than their self-contained counterparts continued into the fifth grade.

At the fifth-grade level, students were split into six groups based on their classroom organization in the third and fifth grades. The groups consisted of the following:

- Self-Contained–Self-Contained
- Self-Contained–Team Teaching
- Self-Contained–Departmentalized
- Departmentalized–Self-Contained
- Departmentalized–Team Teaching
- Departmentalized–Departmentalized

The fifth-grade results resemble those of the third-grade. When comparing all fifth-grade students, there is not a significant difference in the mathematical proficiency between the self-contained and departmentalized students. However, a significant difference in mathematics proficiency was found among the six groups when comparing fifth-grade students of teachers with below-average mathematics backgrounds. At the fifth-grade level, teachers with below-average mathematics backgrounds were those who had:

- not earned an undergraduate mathematics degree
- not earned an undergraduate mathematics education degree
- not earned a graduate mathematics degree
- not earned a graduate mathematics education degree
- taken less than 2.6 college mathematics methods courses
- attended less than 9.6 hours of mathematics workshops in the past year

The averages of 2.6 mathematics methods courses and 9.6 mathematics workshop hours were used since these are the mean number of mathematics methods courses and mathematics workshop hours of all 2,204 fifth-grade teachers in the ECLS-K data set.

When comparing the six groups of students of mathematically below-average teachers, the three groups that received third-grade departmentalization all experienced a higher gain in mathematics proficiency by the fifth grade than the other three third-grade groups that received self-contained instruction. The group that received departmentalization at both the third- and fifth- grade levels (the departmentalized-departmentalized group) experienced the highest gain in mathematics proficiency out of all six groups.

A series of regression models were created. First, regression models were created using just classroom organization and mathematics proficiency gain. Regression models were also created using the stepwise backward-selection method allowing for factors that contribute to mathematics proficiency to be identified in the models. The final third-grade regression model includes variables pertaining to teacher influence on school policy, student gender, percentage of Hispanic students in the class, race of mother, teacher frequency use of work samples, and students' prior mathematics proficiency and IRT scores. The final fifth-grade regression model includes variables related to teacher enjoyment of job, teacher influence on school policy, student gender, region of school, percentage of minority students in the class, class size, and students' prior mathematics proficiency.

4) ***If there is a significant difference, does this difference continue into the eighth grade, and if so, is the higher performing group more likely to end up in a higher-level eighth-grade mathematics course?***

There is an instance where the significant difference in gain in mathematics proficiency continues into the eighth grade – when comparing the fifth-grade students of teachers with below-average mathematics backgrounds. These students experienced a significantly higher gain in mathematics proficiency under a departmentalized setting than their counterparts in a self-contained setting. This significant difference is apparent in the fifth grade, with the departmentalized-departmentalized group having the highest gain of all six groups. This significant difference continues into the eighth grade with the departmentalized-departmentalized group having the highest IRT mathematics proficiency mean. An additional analysis was conducted to determine if there was a significant difference in higher-level eighth-grade mathematics course attainment, and none was found. The eighth-grade level final regression model included variables pertaining to number in household, teacher influence on school policy, school region, student interest, if the student had a tutor, mother's education level, class size, and students' prior mathematics proficiency and IRT scores.

To examine the possible impact of the significant differences found between students of mathematically below-average teachers, the proficiency probability scores, which provide the percentage of students that have become proficient in a particular topic, were analyzed in the topic area of fractions. The biggest gain in the proficiency of fractions at the third, fifth, and eighth grades was experienced by the departmentalized-departmentalized group, with it being the only group where more than half of the students were proficient in fractions by the eighth grade.

These results suggest that a difference of a few points on the IRT proficiency scale can correspond to a fairly large percentage difference in the student proficiency of a particular mathematics topic. This is meaningful, because if policy decisions are to be made based on the findings of this research, the results need to be not only statistically significant, but pragmatically significant as well.

Recommendations

Several considerations may be of interest to NCES, the sponsor of the Early Childhood Longitudinal Studies, which has begun a new ECLS-K, Kindergarten Class of 2010-2011 (ECLS-K:2011). While the original ECLS-K that was used in this study is a very rich data set containing many observations and variables, it did possess some shortcomings that led to several limitations in the analysis of the data.

The first limitation simply pertained to ascertaining which teachers were departmentalized mathematics teachers. There was no direct question asking teachers if they were a departmentalized mathematics teacher. Due to this, the investigator had to examine and link certain variables together to determine the number of departmentalized mathematics teachers at the third- and fifth-grade levels. This method of assessing the number of departmentalized mathematics teachers displayed minor inaccuracies, which likely could have been avoided had there been one direct question asking teachers whether or not they were a departmentalized mathematics teacher.

In third grade, the situation is even worse. While there is a question asking whether a teacher is a self-contained, departmentalized, team, or elementary-enrichment teacher, any classification that is not self-contained has been combined into one classification, so that the coding is 1 – self-contained and 2 – departmentalized, team, or elementary enrichment. This is problematic, because although departmentalization, team teaching, and elementary enrichment share some similarities, they are not the same. Additionally, the presence of departmentalization cannot be determined in kindergarten, first grade, or in eighth grade, as nothing about departmentalization is asked. It is assumed that departmentalization is nonexistent at the kindergarten and first-grade levels and is universal at the eighth-grade level; thus, in only the third and fifth grades can departmentalization be examined.

Also, no data at all were collected in the second, fourth, sixth, and seventh grades. This information would have allowed the researcher to analyze the yearly gain and probably the pervasiveness of departmentalization for more than just two grade levels. This would have allowed for a more thorough analysis providing more certainty of the results. For example, there are students who are self-contained in the third grade, but departmentalized in the fifth grade. It is not known if these students received one year or two years of departmentalized instruction due to this gap in the data. If fourth-grade data had been collected, this could have been determined, providing valuable information regarding departmentalization and its effects.

Another drawback to the ECLS-K data was the amount of missing data. There was a large amount of missing data which increased the likelihood of inaccuracies and required additional time when conducting statistical analyses.

An additional shortcoming is that the ECLS-K data set is not a simple random sample, as not all schools, teachers, and students had an equal probability of selection. Also, the ECLS-K is only nationally representative of kindergartens, kindergarteners and their teachers, and first-graders. It is not nationally representative of 3^{rd}, 5^{th}, and 8^{th} graders or their teachers, because the data were never refreshed at these levels, meaning that children who started their schooling in the U.S. in the second, third, fourth, fifth, sixth, seventh, and eighth grades are not represented in the sample. Thus, the data cannot be used to make generalizable statements about third-, fifth-, or eighth-grade students or teachers, first grade teachers, and schools with first, third, fifth, or eighth grades.

Another downside to the data was that by third grade, attrition had begun. For example, at the kindergarten level of this national data set, more than 21,000 students were assessed, but by 3^{rd} grade, just over 14,000 were assessed. This affects the sample sizes of particular variables and thus the analysis, as the sample sizes and sample variances are not always equal, requiring the need for nonparametric tests.

These limitations call for several recommendations for the ECLS-K:2011. It would be beneficial if data were collected for all of the elementary grades, thus allowing for more accurate and informative results. Furthermore, if direct questions regarding classroom organization (departmentalized, semi-departmentalized, team-teaching, or elementary enrichment instruction) and subject area were asked at all rounds of data collection, then classroom organization and its effects could be studied for all elementary grade levels, and it would be easy to identify who teaches what subject. It is also recommended that ECLS-K:2011 minimize the amount of attrition and missing data, allowing for a consistent and larger sample size. Lastly, the data should be refreshed at every grade level, so that ECLS-K:2011 can be utilized as a nationally representative data set.

It is also recommended that additional research be done with the specific purpose of examining departmentalization. This includes an experimental study where teachers within the same district are randomly selected to teach in either a departmentalized classroom or a self-contained classroom. At the beginning of the school year, the teachers and their students' mathematical proficiencies would be measured. At the end of the year, the mathematical proficiencies would be measured again to determine the gain in the mathematics proficiency of the students and teachers. Throughout the year, observations of the teachers teaching mathematics lessons and an analysis of the effectiveness of these lessons would be done as well, allowing for a comparison of teaching practices between departmentalized and self-contained teachers. I would recommend that this study be longitudinal so that the long-term effects of departmentalization on teachers and students can be assessed.

It is also suggested that a qualitative study be conducted in districts that have recently changed from elementary self-contained instruction to elementary departmentalized instruction. This would allow for an understanding as to why districts choose to implement departmentalization at the elementary school level and a first-hand look at how self-contained teachers become departmentalized mathematics teachers.

Although additional research is recommended, the results of this study do have some important implications and can provide guidance to administrators and teachers who make decisions regarding elementary classroom organization. The findings suggest that at the third- and fifth-grade levels, teachers who are below average in mathematics are likely to provide better mathematics instruction to their students in a departmentalized setting than in a self-contained setting. This could mean that the benefits of departmentalization allow for an increase in the mathematical knowledge (content and pedagogical) of teachers who are below average in mathematics, which in turn leads to a significantly higher mathematics proficiency of their students. Thus, on the other hand, the findings also suggest that classroom organization at the elementary school level has minimal effect on teachers who are strong in mathematics, which is a logical expectation. If a teacher is already very knowledgeable in mathematics, he or she should be able to provide their students with sound mathematics instruction, regardless of classroom organization.

It is possibe that these significant differences in mathematics proficiency could be due to differences in the teaching practices of departmentalized and self-contained teachers. While there are not that many differences between third-grade teachers, there are a plethora of differences between fifth-grade teachers, and at both grade-levels, there are significant differences in the frequency of work samples and textbook-chapter end tests given. These significant differences along with others, e.g. self-contained teachers giving worksheets and using the textbook more often than departmentalized teachers at the third-grade level, intimate that self-contained teachers are more reliant on printed materials, e.g. worksheets, work samples, textbooks, etc. than departmentalized teachers. This is possibly another indication of self-contained teachers' weakness in mathematics.

Another interesting outcome was that team teachers had a significantly higher rate of job enjoyment and were significantly more likely to choose teaching again as a career than self-contained and departmentalized teachers. This suggests that a compromise of departmentalization and self-contained instruction, such as team teaching or semi-departmentalization, may be preferable to teachers. In speaking to departmentalized teachers who had previously been self-contained teachers, some did indicate that while they liked not having to teach all of the subjects, they missed teaching certain subjects and that teaching only one subject could be a bit monotonous. This finding highlights the need for the aforementioned qualitative study that was recommended.

The significant difference between the mathematical proficiency of students who had teachers with below-average mathematics backgrounds essentially corresponds to a difference of a few points on the IRT scale. Thus, it may seem that these results are not pragmatically significant at first glance. Yet, further analysis revealed that these significant differences could lead to a much higher percentage of students being proficient in important areas of mathematics, e.g. fractions. For example, the only group of students where more than half had become proficient in fractions by the eighth grade was the group that received departmentalization in both the third and fifth grades. The next closest group, the self-contained-self-contained group, only had 46% of its students proficient in fractions by the eighth grade, and the least proficient group, the departmentalized-team teaching group, had only slightly more than a quarter of its students proficient in fractions by the eighth grade! Clearly, these differences have real-life significance. If the percentage difference between the top two groups were applied to the 1.1 million students that attend the New York City public schools, this difference would equate to almost 90,000 students that are not proficient in fractions by the eighth grade. The difference between the highest and lowest groups would equate to more than 300,000 students.

Knowledge of fractions is important as research has shown that elementary students' knowledge of fractions and division uniquely predicts their high school mathematics achievement (Siegler, 2012). Additionally, it has been found that students who complete higher levels of mathematics in high school are more likely to go to college, experience lower rates of unemployment, and receive higher salaries than their less-accomplished peers (James, 2013). Also, if students are not proficient in fractions, it is likely they will be placed in remedial classes upon attending college, making them six times less likely to graduate, which again, will lead to their becoming less accomplished than their peers who have graduated from college.

Thus, overall, if an elementary school has teachers who have below-average mathematics backgrounds, it is recommended that the school implement departmentalization, which is likely to increase teachers' mathematical knowledge, thereby increasing the mathematics proficiency of their students. Departmentalization may not only provide an immediate increase in the mathematical proficiency of students, but evidence suggests that it may provide an increase in the mathematical proficiency of the students for years to come, benefitting them throughout the rest of their lives.

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